SCIENCE

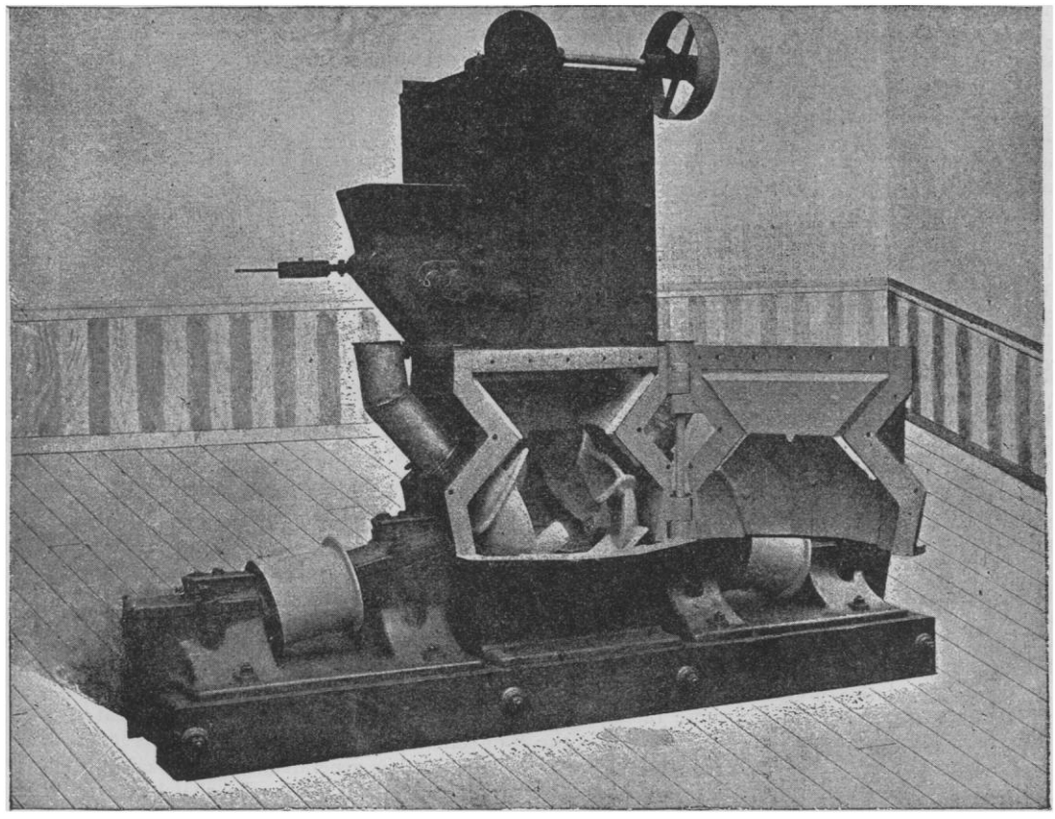
FRIDAY, DECEMBER 28, 1888.

THE McAULEY PROCESS OF BURNING PULVERIZED FUEL.

ONE of the most important problems of the day is that of the economical use of fuel, and much ingenuity has been expended in attempts to find its best solution. We are all interested in this matter, for we are all in some way connected with the fuel question. Iron and steel furnaces, factories, locomotives, steamships, and the domestic hearth, — one and all are most lavish users of fuel. When it is considered that it is theoretically possible to generate one horse-power by the consumption of a quarter of a pound of coal per hour, and this is compared with the results of actual practice, an idea is obtained of the room for improvement. An ordinary non-expansive, non-condensing engine requires commonly from ten to twelve pounds of coal per hour, while in our best expansive and condensing engines the same amount of work is accomplished with only two pounds per hour. But the latter figure represents excellent practice rarely reached by the majority of even large fuel-consumers. The average consumption of coal may be taken as at least four pounds per horse-power hour.

At the present day nearly all efforts to further economize fuel are being exerted in the direction of better boilers and furnaces, more efficient engines, a higher grade of workmanship, and more skilful management; in fact, in the more economical use of the heat after it has been obtained. Many inventors have, nevertheless, with varying degrees of success, attempted the solution of the fuel problem by attacking it from the other end; i.e., by endeavoring to secure the more perfect combustion of the fuel itself, as well as the burning of cheaper fuel than ordinary coal. All manner of patent fuels have been tried, and some with a fair degree of success. Mechanical firing has also been resorted to, but in all such processes there seem to have been objectionable features of great magnitude.

It has long been recognized that if coal could be very finely pulverized, and each little particle of coal could be surrounded with a film of air on its way to the furnace, the combustion ensuing would be very much improved. Many have been the devices to burn pulverized fuel in such a manner; but the success achieved has usually been small, and the difficulties besetting the problem have appeared insurmountable. A very promising effort in this direction is that of Mr. J. G. McAuley of Lansing, Mich. Vague mentions of his method have from time to time reached the public, but it is only within a short time that his process seems to have been brought to practical perfection. In order to satisfy certain capitalists of its merits, the process was applied, some time ago, to one of the puddling-furnaces of the Chester Rolling Mills of Chester, Penn., and the writer enjoyed the advantage of being present for several days during this test. The idea underlying this process is that of the automatic delivery into the combustion-chamber of a regular supply of finely pulverized coal, each little particle of the latter being surrounded by a film of air while on its way to the combustion-chamber; so that, on arriving there, combustion may be nearly instantaneous and practically perfect.



THE CYCLONE PULVERIZER.

The manner of obtaining this highly desirable result is ingenious and extremely simple. The combustion-chamber of the furnace is

tightly closed, having neither grate-bars nor ash-pit. Into the front of this chamber, and on the same level, there enter two short horizontal pipes, or *tuyeres*, about two feet apart. The outer ends of these *tuyeres* are connected to a main air blast-pipe, which is kept filled with air under a slight pressure by means of an ordinary blower. Simple valves permit the ready and accurate adjustment of the amount of air passing through the *tuyeres* into the combustion-chamber. Between and slightly above these *tuyeres* is a small rectangular hopper, into the top of which the finely pulverized coal is fed by screw-conveyers. The coal is fed out of the hopper by means of an ordinary screw of about two inches diameter, which passes horizontally through the lower portion of the hopper, issuing from its opposite sides through holes just large enough to loosely fit the outside of the screw. The pulverized coal lodges between the threads of the screw, and, on revolving the latter, the coal is fed out through the side of the hopper. One end of the screw is right-handed, and the other is left-handed, though both ends are of the same pitch. It follows, therefore, that the coal will be fed out of both ends of the hopper at exactly the same rate, this rate depending on the speed of revolution of the screw. The coal is kept from packing or becoming solidly wedged in the hopper by means of an agitator kept in motion immediately above the feeding-screw. On issuing from the hopper, the pulverized coal drops into the *tuyeres* directly below, and is carried to the combustion-chamber by the blast of air passing through the *tuyeres*, becoming intimately mixed with this air at the same time. Only enough air is admitted to secure complete combustion, thus avoiding the great loss due to the excessive amount of air necessarily admitted when burning lump-coal on an ordinary grate. The feeding-screw is operated by gearing driven from a convenient line of shafting, such arrangements being made as will secure a readily and accurately adjustable motion of the screw, and hence a readily and accurately adjustable feed of the fuel.

As the relative as well as absolute amounts of coal and of air can thus be adjusted at will, and with any desired degree of precision, it follows that the character and intensity of the flame are completely under control. The ability to thus produce, and maintain for any desired length of time, a flame of any desired intensity, and either reducing, neutral, or oxidizing in character, carries with it, for metallurgical purposes, many advantages too well known to need more than a passing allusion.

In the Chester Rolling Mills the apparatus was attached directly to the combustion-chamber of one of their regular puddling-furnaces, though greater economy would probably have been obtained by the use of a special form of combustion-chamber devised for this purpose. The coal was the same as that used for all the other puddling-furnaces, except that it was pulverized. No conveyers were fitted to feed coal into the hopper, the coal being furnished in bags of one hundred pounds each, which were emptied into the hopper as required. As thus applied, this process realized a very large measure of success. The furnace was heated more rapidly after charging than the other furnaces, which were being worked in the ordinary manner, though with the same iron. More heats were obtained per day with the new process, less fuel was consumed per ton of iron produced, less iron was wasted in puddling, and the iron produced proved to be of slightly superior quality. There was no smoke, and the ashes was carried out of the top of the chimney in the form of fine dust, invisible from the ground. While charging the furnace, the supply of both air and fuel was completely stopped, thus preventing waste, and enabling the men to work more quickly. In considering the superior economy of this process, it must be borne in mind that the actual economy in the production of heat from any given fuel does not represent the total gain; for by this process very cheap and otherwise comparatively useless slack coal and coal-dust will answer nearly all purposes, thus presenting another material advantage.

It is of course impossible to give exact figures, except from observations extending over a much longer period of time than was at my disposal at Chester. There can, however, be no question that the McAuley process effects a considerable and substantial gain in economy of fuel-consumption. There remains simply the determination of the exact amount of this gain by means of accurately conducted experiments by scientific and practical experts.

The process has very recently been applied to the puddling-furnaces of the Warren Iron and Steel Company at Warren, O., and the success obtained seems to have been very great. A report of the trial there given this process has just reached me, and reads as follows: —

"The results of the trial just completed at the works of the Warren Iron and Steel Company, Warren, O., with the McAuley pulverized fuel system, are remarkable. The trials covered forty-six on two of the puddling-furnaces. The furnaces were charged with 23,000 pounds of iron during the trial. The amount of pulverized coal used was 12,260 pounds (a little over six tons). The cost of this fuel was $5.43. The amount of iron drawn from the furnaces was 24,029 pounds, an excess of 1,029 pounds over the amount put in the furnaces originally. This is what the McAuley system accomplished.

"By the old process, now in use, during the same heats, the amount of coal required was 36,920 pounds (over eighteen tons), the cost of which was $16.50: in other words, the McAuley process saved nearly 75 per cent of fuel. The McAuley process increased the amount of iron 5½ per cent; that is, there was 5½ per cent more iron taken out by the new process than was charged. This gain is worth $15.45: in other words, the gain in iron alone pays for nearly three times as much coal as is required by the McAuley process. The iron-men who witnessed the trials were astonished at the remarkable results. The iron gained by the McAuley process comes from the 'fix' which is used to protect the pan and sides from the intense heat, and also from the cinder, containing 50 per cent of iron, which is put in the furnaces to flux the iron. By the old process this is all lost, and in addition there is generally over 5 per cent of waste. This means practically an actual gain of 10 per cent of iron by the new system."

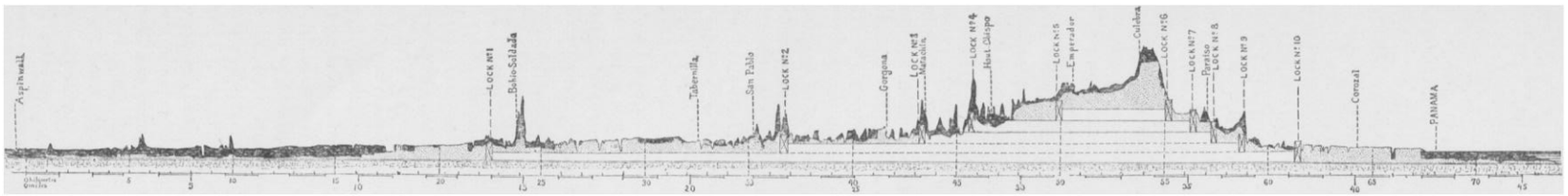
The puddling process makes specially severe demands on any such automatic fuel-feeder; and hence even better results may be expected from the application of the new process to steam-boilers, both land and marine. It should prove especially valuable in marine boilers; for not only would the required speed be developed at less expense, but less coal would have to be carried for any given trip, and the space and weight so gained would, of course, be available for carrying paying freight.

Without going into any further details, it may be broadly stated that there are very few cases in which fuel is consumed in large quantities, where it could not be burned more advantageously in the pulverized form; and, as there can be no question that the McAuley economizer is the best apparatus yet invented for this purpose, it seems as though it were destined to work a great revolution in the manner and economy of consumption of fuel.

In conclusion, it may be of interest to state that the coal is pulverized for this process by means of the Cyclone pulverizer, the principle of which is fairly indicated by its name. Within a closed chamber a pair of wheels resembling three-bladed screw-propellers revolve very near each other at a great velocity, but in opposite directions. Two powerful currents of air in opposite directions are thus generated, their joint effect being to produce a miniature whirlwind within the chamber. Into the vortex of this enclosed cyclone the coal is regularly dropped, and is rapidly ground into the finest powder by the mutual attrition of its particles. There is no grinding or pulverizing by the direct action of any of the metal parts of the machine, so that the machine does a great deal of work with extremely little wear. X.

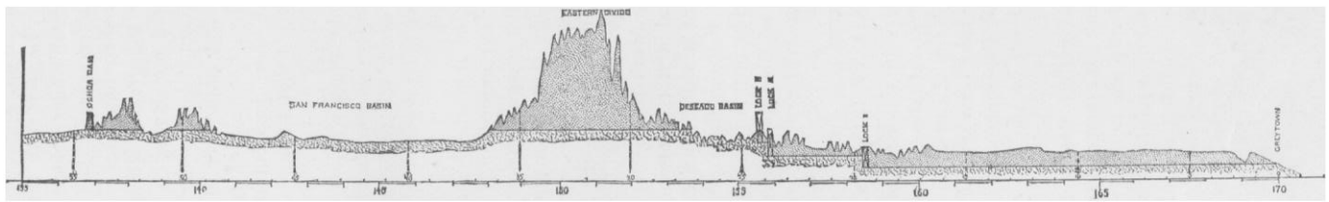
PROFILES OF THE NICARAGUA AND PANAMA CANALS.

THE failure of the Panama Canal Company makes the uninterrupted continuance of work on the canal very doubtful, and thus the chances of the Nicaragua Canal being the first to be completed have materially increased. The profiles on p. 323 show a comparative statement of the amount of excavating to be done in both canals; and it will be seen at a single glance, that, even considering the amount of work already accomplished at Panama, the Nicaragua route is by far the less difficult. The profiles do not show the works necessary for protecting the canal, such as dams

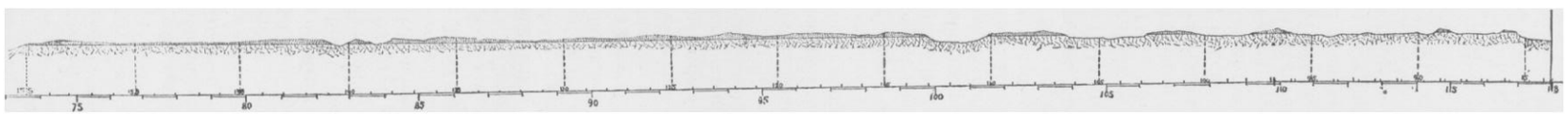


PROFILE OF THE PANAMA CANAL.

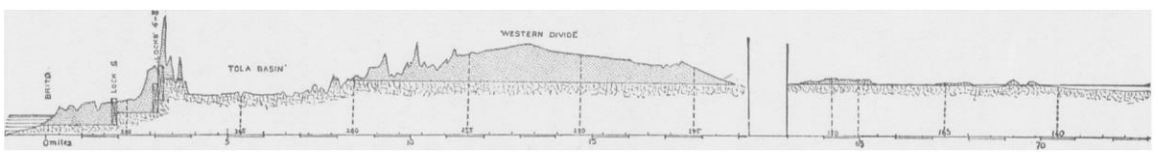
Black indicates work executed; stipple, work to be executed to complete a lock-canal; white, additional work to be executed to complete a sea-level canal.



Eastern Portion: from Greytown to the Dam of Ochoa.



Central Portion: from the Dam of Ochoa to Lake Nicaragua; Bed of San Juan River.



Western Portion: from Lake Nicaragua to Brito.

PROFILE OF THE NICARAGUA CANAL (LOCATION OF 1888).

Stipple indicates amount of work to be executed to complete the canal.

and digging new canals for deviating rivers, etc., but these works are far more formidable in Panama than on the Isthmus of Nicaragua. The control of the Chagres River has been one of the most serious obstacles to successfully carrying on the work at Panama. On the route selected for the Nicaragua Canal by the surveying party of 1885, obstacles of a similar kind would have been encountered in the basin of the Rio Grande between Lake Nicaragua and Brito; but in the new plan of 1888 this difficulty has been overcome by damming up the river, and transforming its valley into an artificial lake, the Tola basin.

On the profile of the Panama Canal may be seen both the volumes to be excavated for the purpose of establishing a lock-canal and a sea-level canal. The number of locks necessary for the former is ten, while the plan of the Nicaragua Canal contemplates only six locks. A single glance shows that by far the greater amount of work necessary to complete a sea-level canal remains to be done, and that comparatively little has been accomplished in the most difficult sections of the canal. While it seems impossible to complete the deep Culebra cut on account of the movements of the soil, no such difficulties are anticipated in the short deep cut of the Nicaragua Canal crossing the eastern divide. Careful borings have shown the soundness of the rock.

If we consider that the Nicaragua Canal Company is just starting its work, while the Panama Canal Company is burdened with an enormous debt; that the amount of work left to be done is smaller in Nicaragua than in Panama, — we must regard the prospects of the former as very encouraging.

The profile of the Panama Canal shows, on the other hand, the amount of work done as compared to that left unfinished. Much money has been expended; and the interests at stake are so powerful, that we do not believe the work will be dropped, but will be pursued in some way or other. A decrease of the working force seems to be, however, at present unavoidable, and this will relieve the Nicaragua Canal Company of another difficulty, the scarcity of workingmen in these tropical regions. If the work on the latter is undertaken without unnecessary delay, and if it is continued as carefully as the preliminary surveys warrant it will be, we expect to see it completed at an early day. The Panama Canal, even if opened at a later day, will have to contend against an established route, run at smaller expense than its own, as the capital invested and the number of locks, which cause increased expense, will be smaller.

THE SPRAGUE ELECTRIC ROAD AT BOSTON.

WE take pleasure in presenting our readers in this issue of our paper with a general view of the new electric street-railway between Boston and Brookline, installed by the Sprague Electric Railway and Motor Company of New York. There have been several trial trips made over this railway already, to test the apparatus, which has been found to be perfect, and the road will be put into commercial operation in a few days.

The West End Street Railway of Boston, of which this road is a part, is the largest street-railway in the world. It extends over 212 miles of track, using 1,700 cars and more than 9,000 horses. The president of the West End Street Railway Company, Mr. Henry M. Whitney of Boston, is universally recognized as being one of the most enterprising and successful street-railway men in the country, and, aided by an efficient corps of assistants, has succeeded in giving Boston since his administration the most efficient street-railway service which ever existed in that city.

Before deciding upon any electric system to be adopted upon the West End Road, President Whitney, accompanied by members of the board of directors and managers, visited all the principal electric railways in the country operated upon the various systems, including visits upon three different occasions to Richmond, Va., to inspect the famous electric road in operation there upon the Sprague system. After a most careful examination of all these different roads, the contract for equipping the West End Road was awarded by the board of directors to the Sprague Electric Railway and Motor Company of New York.

This system of electric railway called for in this contract is wide and comprehensive. The main line from Boston westward, beginning at Park Square, will run down Boylston Street bridge, and then down Chester Park to Beacon Street. It will then proceed over the Beacon Street extension to the Chestnut Hill Reservoir, and to Allston, and Oak Square, Brighton. From the East Park gate, over the new boulevard to the Chestnut Hill Reservoir and Brighton, the Sprague overhead system will be adopted; in the more crowded streets of the city the Bentley-Knight conduit will be used; and the Sprague cars will run over the whole system.

The power-station from which the electric current is distributed to the line is situated on Braintree Street, Allston, near the Boston and Albany Railroad, and also at the edge of the water, thus giving both water and rail facilities for fuel. This building, which is the most perfect electric plant of its kind in the country, is situated very nearly equidistant from the extremities, and is therefore literally a central station. The station, with the adjoining car-house, is of brick, and completely fire-proof.

In its construction it was the aim of the West End Company to get the best in every detail. The chimney-stack is 100 feet high. The boiler-house, which is both convenient and commodious, is at present equipped with three horizontal tubular boilers, furnished by the Jarvis Engineering Company. The engine-room contains two high-speed automatic cut-off engines of the Armington & Sims pattern, of 200 horse-power each. Each drives two powerful dynamos of 80,000 watts each, and wound for a maximum pressure of 500 volts. These dynamos are of the highest efficiency and simplest construction, and, if need be, can be placed under the charge of the steam-engineer. The dynamos feed into copper bus wires, supported on the walls by porcelain insulators.

Each machine has its independent ampère meter, and in addition there is a general ampère meter at the end of the positive bus bar. From this bar the current passes to special snap-switches, each switch being connected through a three-plug safety-switch back to one of the feeders supplying current to the main line-wire. These feeder-wires tap into the line-wire at different points on the line of road, thus maintaining the pressure approximately equal all along the line. At the ends of the feeders in the central station, pressure-indicators are attached, which indicate the voltage at the junctions of the feeders with the main current-wire.

The engine-room is brilliantly lighted by handsome hanging electroliers, each of which has five incandescent lamps. A switch-board at one end of the room furnishes an independent control for each group of lamps. All the surroundings of the machines are kept in the neatest condition.

Adjoining the power-house, but separated by thick brick walls, is a commodious house for accommodation of cars, 107 feet long by 80 feet deep, designed to hold 24 cars.

The overhead system, which is built under the Sprague patents, is of the finest description, and includes iron poles set in concrete throughout the entire length of the road. These poles are of a very neat and tasteful pattern, and support the span-wires which carry the trolley-wire at a height of 18 feet over the centre of the track. This overhead wire, which is used for a working conductor, is made of silicon bronze, of the small Sprague type, only three-sixteenths of an inch in diameter. This is the only wire suspended over the middle of the track, and its lightness and high tensile strength allow the overhead supporting structure to be of the lightest description possible. The poles are 125 feet apart.

The return circuit is through the rail, and thence by both metallic and ground circuits to the station. Each section of rail is joined to copper ground wires throughout the length of the road underneath the string-pieces. At intervals of 500 feet this ground wire is connected to an earth plate, and at seven points widely distributed. The ground wire is connected to the station, and there is also a main ground connection made there through a large sink-plate.

In the overhead system a new method of switching has been adopted, which is at once ingenious and simple. Five or six feet inside the turnouts a small switch with flaring rider is interpolated into the main and branch wires, and a spring tongue upon this directs the path of the trolley with absolute certainty and ease. By this means, switching is made very easy, and all danger of the trolley leaving the wire is obviated.

The cars can be run at widely different speeds, varying from the slowest crawl to twelve or more miles per hour. They can be

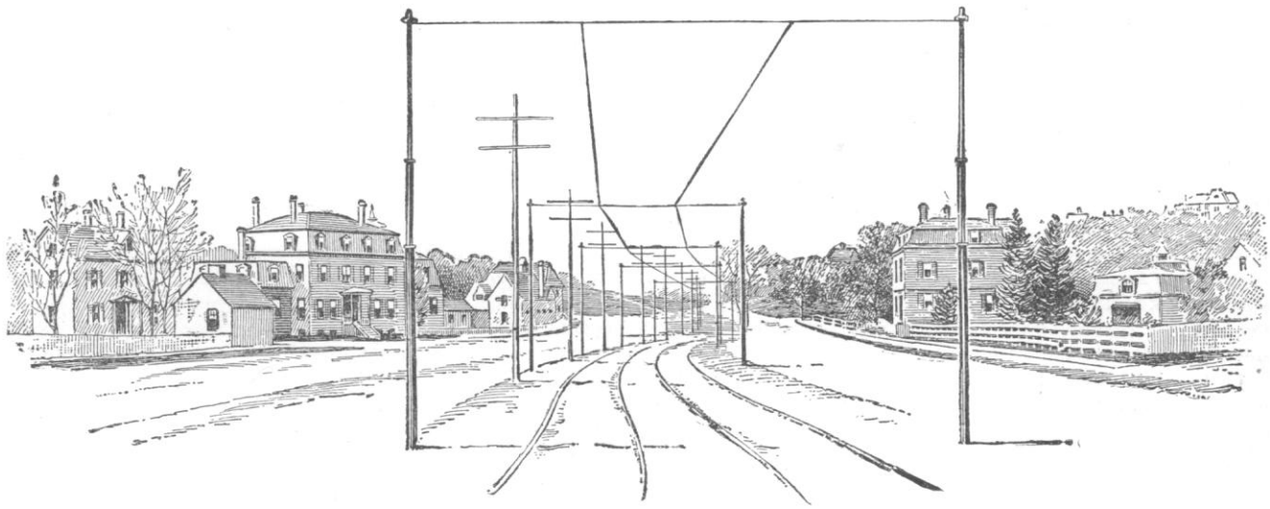
started and stopped without the use of brakes in the space of three or four inches, and, when making the normal running speed, can, in an emergency, be stopped and reversed without brakes within less than a quarter of a car length. This is especially advantageous in crowded thoroughfares, and shows the superiority of the electrical car over the horse or cable cars. The control over the car seems marvellous, for one sees little or nothing save an almost imperceptible movement of the hand of the motor-man; and the starting, although prompt, is very gradual and without shock or jar. The ordinary driver can operate one of these cars without the slightest trouble, after a very brief instruction. The saving on the operating cost of the Sprague system, owing to the superior quality of the apparatus, over an ordinary horse-car line, constitutes a no inconsiderable item. It has been found that the average cost of motive power per car a day throughout the United States — that is, for from ten to eleven hours, and trips aggregating from forty-five to fifty miles — is about four dollars, and this counts only those horses on actual duty on the road. The cost of motive power per day per car for equal mileage in Richmond is less than two dollars on the heaviest sort of grade-work, and at Boston it is estimated that even this low cost of operation will be reduced. For winter use upon this road the Sprague Company is equipping three electric 'working-cars,' furnished with snow-ploughs, brushes, ice-cutter, and salt-distributer, and each propelled by two powerful 30-horse-power motors. In front of the car is a revolving wheel which breaks up the snow-crust completely, and behind are revolving brushes which sweep the tracks clean. It is estimated that this 'working-car' will clear a street-railway track after a heavy storm more quickly than the ordinary snow-plough drawn by 12 horses.

The system of wiring which the West End management has adopted for the crowded city streets is the Bentley-Knight conduit, now in use in Allegheny City, Penn. Here the conduit is laid midway between the tracks, and is strongly bolted to the stringers and sleepers. Its cross-section is about a foot square, and its upper part has a slot similar to that used in cable-railways; its width, however, being only five-eighths of an inch, giving an opening so small that carriage-wheels will not catch in it. Besides this, it is so bevelled that horseshoe calks will not be held in it. Copper bars an inch and a quarter thick, one on each side of the slot, firmly insulated beneath it, carry the current, — one from the dynamo, and the other returning from the motors. The current is taken from the conductors to the motors by 'ploughs,' as they are called, two to each car. These ploughs are thin iron plates about ten inches square, hung from a framework over the middle of the track, and projecting into the slot. The motors are connected by controlling-switches, and the car is operated substantially as is the overhead system. The ploughs are so arranged that they can be lifted out of the slot when any obstruction is reached. The current is taken up and returned by spring-plates, which slide along the copper conductors at the bottom of the plough.

In switching, two ordinary tongue-switches are used, — one in the conduit, and one on the rail. Brushes attached to the snow-ploughs and cars easily keep the conduit and tracks clear, even in the severest snow-storm or in case of slushy and muddy weather.

The change from the overhead system to the conduit is made while the car is in motion, and without the slightest delay in travel or inconvenience to passengers; so that the Sprague cars run over the entire distance.

The kind of truck used upon this road is the latest Sprague improved truck, which has been fully described in these columns. The equipment of this truck includes the new Sprague 'Boston' motor, which will be used, for the first time in commercial work, upon this road.



BEACON STREET, WEST FROM HARVARD STREET.

MOHAMMEDANISM AND SLAVE-TRADE IN AFRICA.

THE recent events in Africa have shown the enormous power Mohammedanism exerts in that continent. The growth of the empire of the Mahdi, the foundation of states by the Fulbe, the steady progress of Mohammedanism in the Galla country, prove its vast historical importance in Africa. We have shown on the accompanying map the distribution and growth of Mohammedan power in Africa according to an interesting study by A. Oppel, published in the Journal of the Geographical Society of Berlin.

Christianity early penetrated into Egypt, and from this point spread rapidly up the Nile as far as Abyssinia, and all over the north coast of the continent. In Egypt many of its dogmas were developed under the influence of Alexandrinian philosophy, while some of the ceremonies of ancient Egyptian worship found their way into the Christian cult. Here, also, many dogmatic controversies originated, which were the cause of long-continued wars. The Christian Church in Africa disintegrated, and at the same time was degraded by assimilating numerous heathenish elements. When, therefore, Mohammedanism first entered African territory, the ancient Christianism was swept away. In 640 A.D., Omar's general, Amru Ibn al Assi, invaded Egypt, which had been a province of Byzantium, and in 641 conquered Alexandria. In order to secure his hold upon the newly conquered province, Omar settled a number of Arabian tribes in Egypt, and through their influence numerous natives adopted the Mohammedan faith. Amru next subjected the western borderland of Egypt, and his successor, in 664, conquered Fezzan. In 711 the whole of North Africa was under Arabian sway. The native Berbers as well as the descendants of the Greeks and Romans, soon adopted their faith and language.

In the sixteenth century the power of the Berbers had increased considerably, and by acknowledging the authority of a Berber caliph they became independent of the Oriental Empire. As the number of Arab immigrants was originally small, they began to be merged into the Berbers; but in the middle of the eleventh century several nomadic tribes who had lived in upper Egypt

emigrated westward, and penetrated far into the interior, thus giving Mohammedanism and Arabian influence a new impetus. In the beginning of the eleventh century the new religion had reached the great northern bend of the Niger, and since that time this region has been one of the central points and strongholds of Mohammedanism, and at one time the seat of high culture and of science. It seems that about this time the Fulbe adopted Mohammedanism. Arabian immigrants began to settle also on the eastern slope of Abyssinia. They intermarried with the natives, and founded a Mohammedan empire. The progress in Central Sudan was steady. About the year 1600 Baghirmi had become a powerful Islamitic state, and a little later Wadai had embraced the same faith. While in the eighteenth century little progress was made, a new period of advance dates back to the early days of our century, when the Fulbe, led by the fanatical priest, Otmann dan Fodio, attacked the heathenish Haussa States, and subjected them. The two states Gando and Sokoto, and, later on, Adamaua, which forms a portion of Sokoto, were founded. On the upper Niger Mohammedanism made progress in consequence of the uprising of the fanatical marabout El Hadj Omar, who subjected the region on the upper Senegal and Niger, and converted a great part of the Mandingo.

The Arabian supremacy over the east coast of Africa, which was first gained about 1700 A.D., was lost again in consequence of disagreements among the conquerors; but about the end of the last century the Sultan of Oman made an effort to re-occupy the coast, which has been held by the Arabs since 1838.

We have thus outlined the limits of Mohammedan Africa. Mohammedan traders, however, penetrate much farther into the interior, and with them the devastating slave-trade. It will be seen from our map that the area of slave-trade in a general way adjoins the Mohammedan area, and that it has almost invariably its outlet in Mohammedan countries. The demand for slaves arises principally from two sources, — from the domestic wants of the Mohammedan peoples, and from the necessity of obtaining carriers for the ivory-trade. In describing the extent of this trade we follow A. J. Wauters's sketches in the *Mouvement géographique*.

In the period following the Conquest and the establishment of plantations in America, the American land-owners who needed workmen began to import slaves from the west coast of Africa. Some figures will best show the extent of this trade. In 1600 the government of Philip II. made a treaty with the governor of Angola, according to which the latter engaged to furnish to the Spanish colonies 4,250 slaves annually. The price paid for this monopoly was 162,000 ducats. In 1701 this monopoly was held by the Portuguese Guinea Company, who had to furnish "10,000 tons of negroes" annually. The number of slaves furnished by the various companies holding the monopoly increased steadily, and in 1786 not less than 38,000 slaves were imported into Spanish America. From 1811 to 1820 Cuba received over 116,000 negroes, and in Brazil as many as 50,000 were imported in 1849.

From these figures it is easily understood why, even at the present time, many parts of the west coast are still depopulated. One of the principal regions of slave-hunting was the lower Kongo, whence, according to Monteiro, 100,000 slaves were exported annually. The trade on the east coast was not less flourishing, the principal market being Zanzibar. As is well known, this maritime trade has ceased to exist. Owing to the abolition of slavery in all Christian countries, the demand, and at the same time the necessity of supplying it, have ceased. On the east coast it has also become very insignificant owing to the endeavors of European nations, except on the coast of the Red Sea, whence Arabia and Persia continue to be supplied.

While thus Africa has ceased to supply foreign markets, the internal demand continues to be very large, and causes the continual spread of the area devastated by slave-hunters. We may distinguish four areas, — the western Sudan, the upper Nile, the lake region, and Lunda.

In western Sudan the sultans of the Haussa States frequently wage war upon their southern neighbors in order to obtain slaves, which are used for paying tributes, for building new residences, or for sale in order to fill the treasuries of the states. Kuka, the capital of Bornu, west of Lake Tsad, is one of the important slave-markets. Rohlfs states that he saw there a caravan of four thousand captives, which was about to be sent northward for sale. The surplus of slaves of this region is sent across the Sahara. For a long time Morocco was the chief consumer of these slaves, but the trade with that country is declining. Fifteen years ago Rohlfs estimated the annual import at ten thousand heads. The trade with Egypt has almost ceased, but now and then caravans reach its western boundary. Thus in 1871 a convoy of two thousand slaves arrived from Wadai, and even as late as 1880 slaves were sent there from western Sudan.

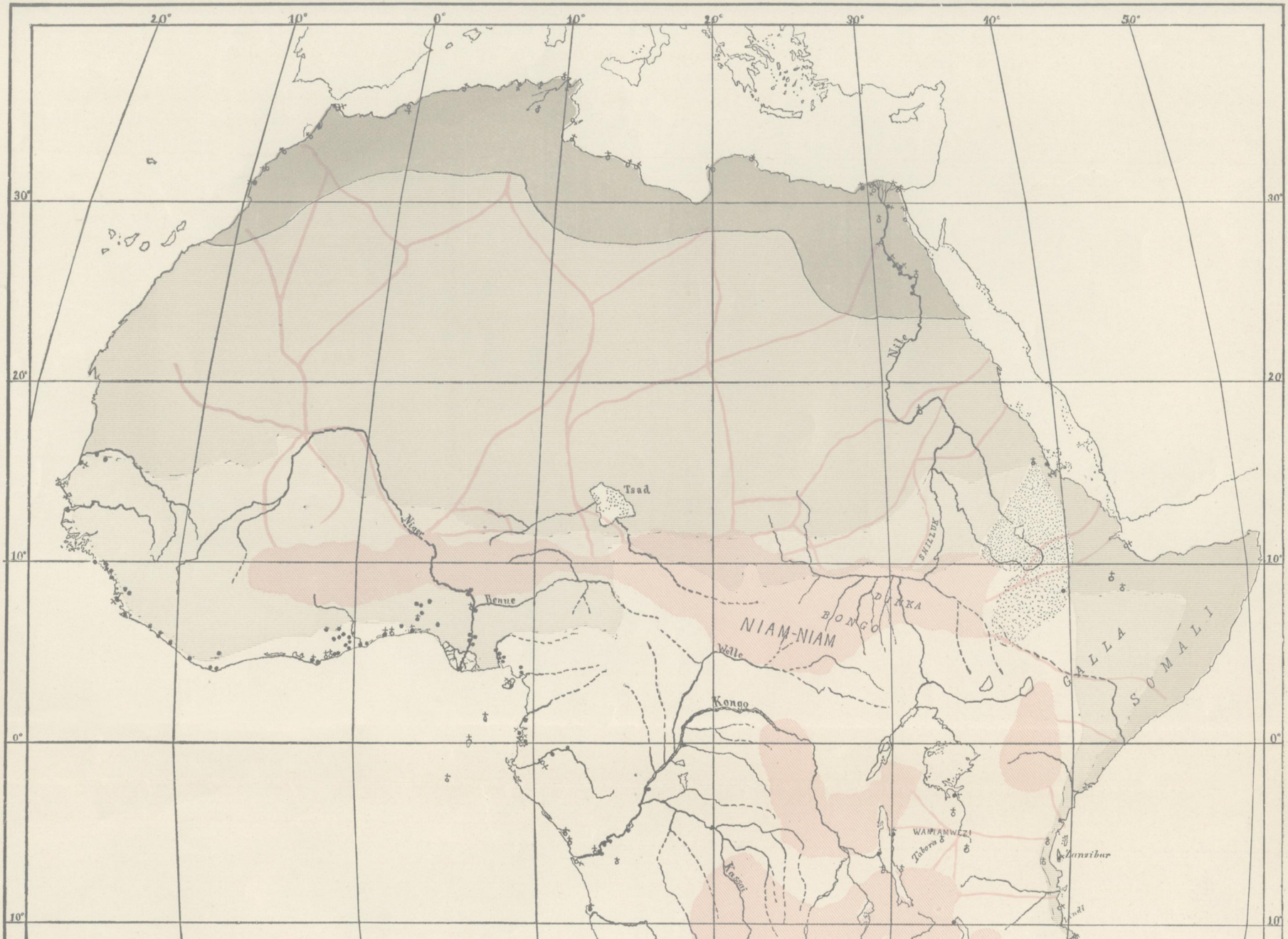
In eastern Sudan the slave-trade is not less flourishing, but here it is due to other causes. The region devastated by it embraces Bahr-el-Gazal, Jebel-Nuba, Dar-Fertit, and the country of the Shilluk and Niam-Niam. The ivory-trade created here the demand for slaves. Every year the merchants of Khartum sent armed expeditions into this region in order to collect ivory. These expeditions ascended the Nile, and began their transactions in the region of the tributaries of the Bahr-el-Gazal. They established at short distances stockades, called 'seribas,' which served as the basis of their operations. They subjected the natives, and compelled them to serve their purposes. In course of time these seribas became centres of slave-hunting, the negroes being not only compelled to assist in the ivory-hunting expeditions, but being exported for sale. During the time of Gordon's administration there was a slight relax; but, since the Mahdi has obtained control of the whole region, slave-hunting is once more flourishing. It is estimated that annually 30,000 slaves are taken from this region. This state of affairs is the more to be regretted, as this is one of the most densely populated and highly cultivated regions of Africa. The slaves are sold to the upper Nile provinces, Nubia, upper Egypt, and Darfor. They are also sent to the Red Sea, whence they are exported to Arabia.

At the present time, particular attention is called to the slave-trade in the Tanganyika basin and on the upper Kongo. Tabora, Udjidji, and Nyangwe are the principal markets in this region. It is only since a recent date that this territory has been devastated by the Arabs. Towards 1830 they reached Tabora in extending their commercial enterprises inland, and in 1840 they established a factory on the Tanganyika. In 1868 they had reached Nyangwe on the upper Kongo. From 1830 to 1870 immense caravans of slaves were transported to Zanzibar, and large tracts of land were devastated. The endeavors of the European nations to prevent the exportation of slaves have suppressed this export, but the ivory-trade still demands enormous numbers of carriers. The Arabs in Africa are also agriculturists, and enslave negroes in order to cultivate their fields. To fill these demands, they continue their razzias, and these are of course most devastating in territories into which the Arabs have recently penetrated, and where they have no workmen at their disposal. As soon as new means of transporting the ivory from the interior to the coast are found, the slave-trade will become less extensive. For this reason it is to be hoped that the Kongo Free State will soon succeed in opening a regular service between Stanley Falls and Leopoldville, as this will save the upper Kongo basin from a great part of the devastations of the slave-trade.

The last important territory subjected to the ravages of slave-hunters is the empire of Lunda. Here Portuguese half-breeds take the place of the Arabs of East Africa. It seems, however, that, in consequence of energetic measures of the Portuguese Government, this trade will rapidly decline.

It is to be hoped that the steps recently taken by many European nations to finally suppress the export of slaves will tend to diminish the demand; but a total suppression of the slave-trade cannot be effected without new means of communication in Central Africa. The social institutions of Mohammedan North Africa are such, that any attempt to prevent slave-hunting in western Sudan must fail, as it is impossible to influence the peoples who create the demand for slaves.

THE Congress of Americanists, composed of some of the most distinguished scientists of Europe engaged in the study of the prehistoric nations of America, which recently completed a very important and successful session in Berlin, voted to meet in Washington in 1890.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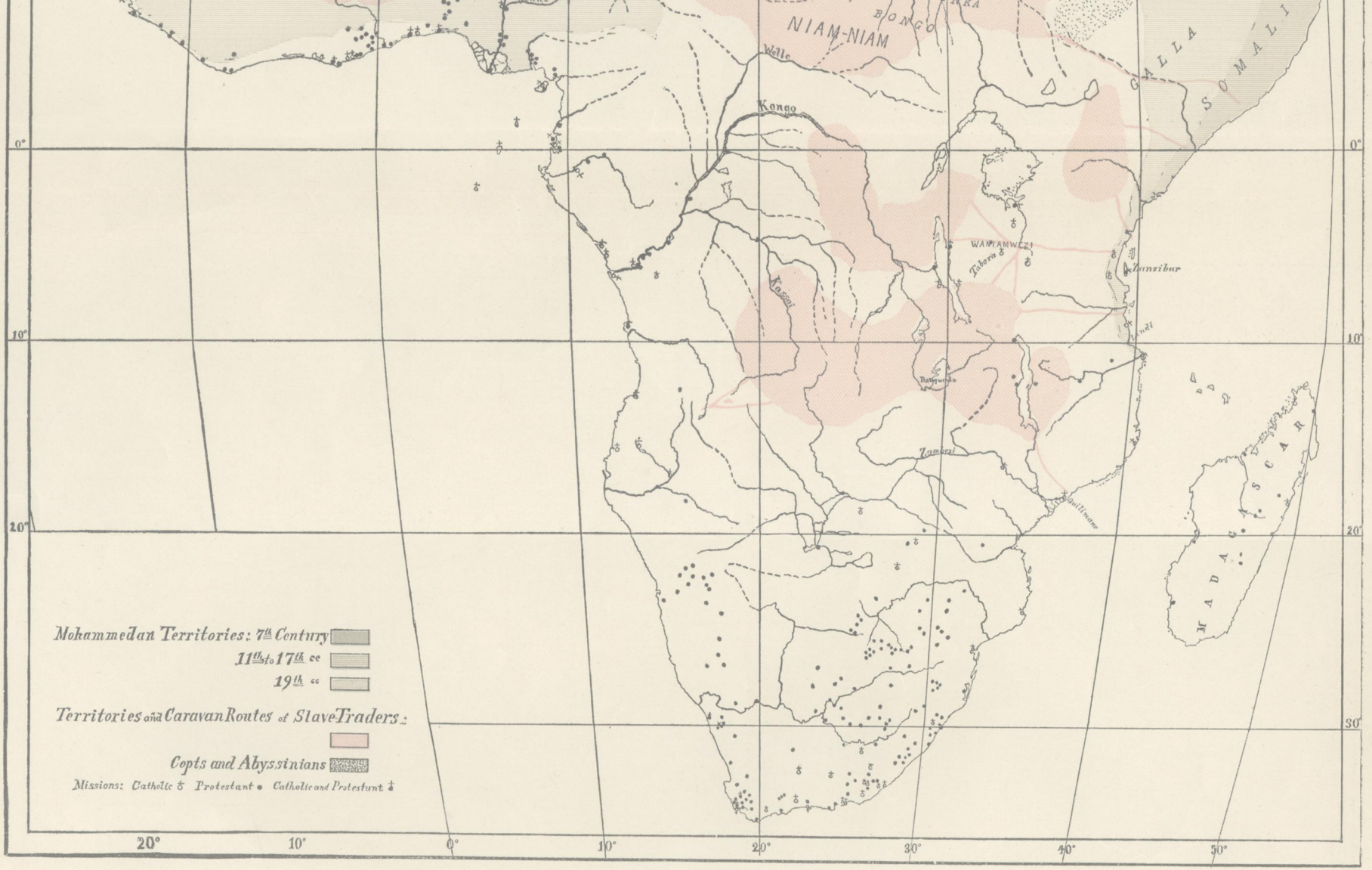

SCIENCE, *December* 28, 1888. *No.* 308.

MAP OF AFRICA,

Showing the Spread of Mohammedanism and the Extent of Slave-Trade.

MENTAL SCIENCE.

Brain and Sociability.

THIS is the title of an address delivered at the Congress of German Naturalists of this year, by Prof. Theodore Meynert, whose works on the nervous system have given him a world-wide reputation. Like much that he writes, it contains many digressions, and in particular enters into details concerning the nature of instinct. The portion of the address most germane to the title is reproduced in abstract here.[1]

The struggle for existence has its origin in the tendency of organisms to multiply indefinitely. Sociability consists in the moderation of this strife; in the more or less conscious resolve of a certain portion of the animal kingdom to live and let live. The Hindoo philosophy attempts to embrace the entire animal world under such a law, but this is practically impossible. The Christian ideal of a single brotherhood of man is realizable, because it includes but one animal species. Such communities confined to one species, or still more frequently to one society, are to be seen in the animal world. The organized troops of elephants, the communities of ants and bees, illustrate it abundantly. With what kind of psychic or physiological activity to connect these manifestations is a question capable of various answers. One finds it difficult to draw the line separating the conscious from the unconscious, the designed from the instinctive, the voluntary from the reflex. It is somewhat less hopeless to arrange organisms by means of an anatomical comparison of their nervous systems. This would not coincide with the zoölogical scale throughout; for the *Amphioxus*, though a vertebrate, has almost no brain. By the classification here adopted, the ant and the bee would stand high in the scale. In man the cortical organ is situated to one side, the reflex organs to the other side, of the base of the cranium; and the ganglia furnishing communication with the organs of sense are between. In the same way in the invertebrates the ganglia anterior to the œsophageal arch are subordinate to those posterior: they play the *rôle* of higher and lower brain, and have the same significance as voluntary and reflex action have in the vertebrates. In the ants, according to Forel, the greater the intelligence of the animal, the more developed are these ganglia. Passing upward from the leech to the water-beetle (*Dytiscus*), to the ant, one passes from a nervous system in which the inferior cerebral ganglia are larger than the superior, to one in which they are equal, to one in which the superior gains the ascendency. Forel finds among ants that these ganglia are much reduced in the incapable males, a little larger in the females, and well developed in the workers. While consciousness need not be exclusively connected with these anterior ganglia, their high development eclipses the powers of the lower centres; and this seems to be the more perfect the greater the excess of the superior over the inferior ganglia.

The methods by which the sociability is retained among animal communities, — the power of communication, the power of recognition of friends and enemies, the selection of a single queen so that there shall be unity in the government, — all this need not detain us here. The point to be noted is the type of sociability represented by an insect community, — a sociability limited in its scope, but within that limit rendering the struggle for existence less keen. An ant of another species is treated as an enemy: degree of resemblance determines communism. Sympathy is not developed among the lower animals. Nutrition is the prime object of each. The most common dependence of one animal form upon another is parasitism. Parasites have been divided into those that do not feed upon the animal itself but take its nutriment, those that make return for what they take, and parasites proper. Parasitism in general is the anti-social characteristic both in animals and men. Its most perfect expression is 'slavery;' while 'reciprocity,' 'mutualism,' is the essence of all sociability, and is the ideal towards which civilization is striving.

From this general point of view the enemy of sociability among human communities, that is crime, is nothing but a form of parasitism. This it is that binds together criminals of all grades and nations. It is a lack of the true social instinct. In the natural development of the child, one can distinguish two *egos*. The primitive *ego* is formed by the consensus of sense-impressions, the motions, the pleasures and pains, yielded by its environment; and its activity is directed to the preservation of itself. Upon this is built a second *ego*, which, however, is not limited, like the earlier. It unites the individual to other men: it makes one share the life of all. It founds societies, and is the true germ of 'mutualism.' It contributes its activity to the general welfare of all. This wide scope of the secondary *ego* is gained by an increase of intense cerebral work. Its motives of action become so complex and so many, that the mind can no longer contain them. It brings about an ethical, a social feeling, that prevents what is harmful to the community, and opposes it.

The deprivation of a moral sense would thus be a kind of imbecility. It is a deficiency in the secondary *ego;* it reduces an individual to the stage of childhood in which self-preservation is the only end. The criminal retains the parasitic nature of his infancy, feels his life to be different from those of his kindred, and is thus excluded from the sentiment of sociability except towards those like himself. In as far as this is a mal-direction, and not an absence, of the moral sense, it is subject to reformatory measures. Other forms of anti-social psychic conditions exist, such as mania and the entertainment of delusions. One can follow the mechanism of sociability into the brain. The anterior portions of the brain exercise a control over the lower centres, — those connected with the exercise of sense and the individual functions. The anterior brain, then, can be regarded as the organ of sociability. Its development increases the sense of 'mutualism.' The superiority of the lower centres brings about the anti-social characteristics. Here are centred the parasitical, purely personal tendencies.

[1] *Revue Scientifique*, Nov. 24, 1888.

NOTES AND NEWS.

THE growth of the electrical industry in a direction in which less has been done, perhaps, than in some others, is shown by the formation of the Anglo-American Electric Light Manufacturing Company of this city, for the manufacture of a storage-battery which they believe to have many merits. It is claimed that the accumulator they are making requires no washing-out from the time it is started till it is ready to be thrown aside; that it will last five years, which is guaranteed by the company; that it will yield 90 to 92 per cent of the current put into it; that it will not buckle or break; and that it requires no expert attendance. We hope to publish a description of the battery, with illustrations, at an early date.

— In *The Critic* of Dec. 15, Mr. O. B. Bunce has an article on 'Christmas Books,' in which he ascribes the greatest activity in the bookstores during the holiday season to the purchase of children's books, of the works of poets, essayists, romancists, and historians, of Bibles, prayer-books, hymn-books, and albums, and of numerous miscellaneous selections; the gay and sumptuous volumes, which occupy so large a place on the counters, which have been produced at such great cost and with so much watchful care, filling but a small part in the general bustle.

— We learn from *The Electrical Review* that an electrical locomotive is building at the New York Locomotive Works, in Rome, N.Y. The engine is to be operated solely by electricity, and is designed to run on all roads where steam is now used. It will weigh fifteen tons, and when turned out of the shop will be an exact counterpart of an ordinary locomotive, though considerably smaller and lighter. When finished, an electrician from New York will take charge of it, and place in it the electrical apparatus to be used as a motive power. The inventor is W. H. Darling of Brooklyn.

— Recent experiments with a submarine boat, 'Le Gymnote,' made at Toulon, have been very successful. The boat moves horizontally as well as vertically, and is easily kept at any depth that is desired. It can be run at a speed of from nine to ten knots. The light is good, and respiration easy. Its crew is ordinarily three, but during the experiments five persons were on board. The *Revue Scientifique* says that the new boat, an invention of Mr. Krebs, is a complete success, and will become of the greatest importance in marine warfare.

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VOL. XII. NEW YORK, DEC. 28, 1888. No. 308.

CONTENTS:

WE PRINT at another place in this number a brief account of the spread of Mohammedanism in Africa. While we may consider its influence upon the heathenish tribes of Africa as detrimental, we must not underestimate its vast historical importance. People like the African aborigines are not roused to activity by the teachings of Christian missionaries; the appeals of the Mohammedan dervishes, which instigate their passions and arouse their warlike dispositions, are more likely to raise peaceful tribes to historical importance. The power of Mohammedanism to create commotions of vast historical importance has been frequently shown. It shows itself at present in the whole Sudan, and, notwithstanding the endeavors of all European nations, it is doubtful whether it will be possible to stay its progress and to redeem Africa from the curse of slavery. The existence of slavery is inseparably connected with that of the Mohammedan states. The present endeavors of the European powers which are directed against the East African slave-trade have some chance of success, as there are no inaccessible Mohammedan states in that region, and the slave-trade is kept up principally by a small number of individuals. Cardinal Lavigerie, to whom this movement is partly due, maintains that five hundred trained soldiers marching through the German territory by way of Unyanyembe to Udjidji, on Lake Tanganyika, could crush the slave-trade and disarm and forever disable the Arab slave-merchants; but slave-raids of some form or other will continue to exist until means of conveying goods from the interior to the coast have been found, making unnecessary the use of carriers. It seems, however, that the principal region of slave-trade, that of Sudan, must for a long time remain inaccessible to European influence.

THE ADVANCES IN ELECTRICITY IN 1888.

WHEN we contrast the present state of electric science and industry with their condition a year ago, we are struck with the remarkable advances that have been made, especially in the latter. The most important experiments bearing on the theory of electricity have been those of Hertz on the propagation of electrical disturbances, with investigations by various workers on the effect of light on various electrical phenomena. Hertz has obtained electric oscillations of a very short period, — several hundred millions in a second, — and he has shown that electro-magnet waves caused by them are propagated in the surrounding space, and are reflected and interfere with one another as do waves of light. To those who have not believed the electro-magnetic theory of light, these experiments will be of great importance: for those who have believed the theory, they will add corroborative and strengthening evidence. Our general views of the electric current have been gradually changing; and the idea of the energy of the current being transmitted through the surrounding dielectric, and entering the wire at every point, is changing our methods of treating problems of current propagation and our conceptions as to the mechanical reality that underlies the phenomenon. A number of experiments on the discharge of condensers have been made, notably by Professor Lodge, with a view of developing a theory of lightning, and of providing the best means of guarding against lightning-strokes. There grew out of Professor Lodge's experiments a warm discussion before the British Association, on lightning-conductors, in which there was shown a wide difference of opinion between 'theoretical' and 'practical' men as to the best means of protection against lightning, and the interest aroused promises to be the means of adding largely to our knowledge on the subject. The development of the alternating system of electric lighting has stimulated investigations in that direction, and a number of experiments on self and mutual induction, on induction-coils, etc., have been made.

In the application of electricity the advance has been much more striking, especially in this country. In lighting, the increase in the number of lights has been steady and rapid; and, although no radical improvements nor fundamental discoveries have been made, yet the efficiency of all of the lighting systems has been increased, and the expense reduced. In arc-lighting there have been only changes in detail of the important systems; but the number of new stations being equipped, and that have started in the last year, greatly exceeds the showing made in 1887. Incandescent lighting has progressed still more rapidly. The Edison Company has erected central stations of large capacity — up to a maximum of 50,000 lamps — in New York, Philadelphia, Chicago, and other cities, besides adding to the already long list of smaller stations. They have increased the efficiency of their incandescent lamps, and have perfected their dynamos. The returns of stations using this system have been for the year most satisfactory, and it is stated in some of the technical papers that a large amount of capital — no less than ten million dollars — has been subscribed abroad for the extension of the system. The number of electric motors that have been supplied from central stations has also largely increased. The Westinghouse Company has continued to distribute electricity by the alternating system, and has rivalled the increase of the older Edison Company. The advantages of their system for distributing to scattered points, and even in cities where overhead wires are allowed, and where the lights are not concentrated in a particular neighborhood, — the lighting of stores, halls, theatres, etc., — are apparent. The efficiency of their converters and lamps has been increased, and experiments are being carried on with a view to perfecting some motor that can be used on alternating circuits. Other companies are doing a great deal of business in a quiet way in putting in private installations for factories, offices, etc. There has

been much rivalry in electric lighting, and three of the most important companies — the Edison, the Westinghouse, and the Thomson-Houston — are at swords' points, and much of the current technical literature consists of discussions as to the merits and demerits of the various systems.

But it is in the extension of power-distribution by means of electricity that the year has been most memorable. Large numbers of electric motors have been installed for supplying powers from $\frac{1}{10}$ to 40 or 50 horse-power, and these are fed from the local lighting companies, and have displaced small steam and gas engines. The uses to which they have been applied are innumerable, and they are increasing in favor as their economy and efficiency become more apparent. More ambitious installations have been carried out in the Western mining districts; the most noteworthy being the power plants at Aspen, Col., and on the Feather River in California, where the Sprague Company has transmitted power (in the last case a distance of nine miles), and at Virginia City, where the Brush Company has just effected an installation. Electric street-railways have more than kept pace with stationary motor-work. The first large road equipped was the Richmond road of the Sprague Company, the largest and most difficult installation that had ever been attempted. After numerous disappointments, and after overcoming difficulties that would have disheartened any less energetic and efficient company, the road was successfully opened in March, and has been running without interruption ever since. There is little doubt that to the success of this tramway is due the boom in electric-motor cars, that has given the Sprague and other companies a business even greater than their large capacity. The Sprague Company has finished or is equipping thirty street-railways; the Thomson-Houston Company, as many more; while the Daft Company has under way or finished a dozen or fifteen. All of these roads have overhead wires to convey the current from the dynamos to the motors. It is probable that the ultimate system of street-car traction will be by storage-batteries on the car, supplying current to motors beneath them, geared to the axles. During the year there has been little progress in this system of traction. One or two cars are being run in New York, in Philadelphia, and in some of the Western cities. The progress has hardly, however, been satisfactory. The present type of storage-cell is heavy and inefficient, and rapidly deteriorates; and the year has not seen the introduction, either here or abroad, of any new type of battery, nor any marked improvement in the old. For exceptionally favorable roads, where there are very light grades, storage-battery cars will cost about the same as horses, or perhaps a little less; but there are few such in the States.

No important inventions in industrial electricity have been developed during the year, although several very promising ones have been patented, and are being improved and tested. The Tesla motor for alternating currents is being developed by the Westinghouse Company; several plans for continuous-current conversion are being experimented on; new types of storage-battery have been described, and will possibly prove successful. Nothing important has been done in the telephone line. In telegraphy Professor Gray has developed a writing-telegraph, which will possibly do what is claimed for it, but which seems very complicated.

There has been much patent litigation, and important decisions have been rendered here and abroad. In an English suit Edison's fundamental patent on carbon filaments for incandescent lamps was badly damaged, although the decision has been appealed from, and it is again being tried. The patents of the Westinghouse Company for the alternating system have been decided against, both in England and this country. The Supreme Court has decided that the government has the right to bring suit against the Bell Telephone Company to annul Bell's patent, but this decision is of interest only as establishing the general right of the government to bring such a suit. A number of important suits are pending on patents for storage-batteries, incandescent lamps, systems of distribution, etc.; and after the holidays a case before the Supreme Court will decide whether Edison's fundamental patents on electric lighting have expired with the limit of the foreign patents.

On the whole, the year has been one of solid advance and improvement, but with no startling development nor revolutionary discovery.

THE SCIENTIFIC WORK OF THE JOHNS HOPKINS UNIVERSITY.

IN considering the scientific work at the university, President Gilman laid emphasis, in his recent annual report, on those parts of the work which are of widest interest, especially on the investigations and publications which have been encouraged, and the opportunities afforded for the education of advanced students. The trustees and the faculty of such an institution need frequently to recur to general principles, ask themselves what they have undertaken to do, and carefully weigh the results of their labors. Accordingly a brief restatement of some of the considerations by which they have been influenced introduces the record of the year. Far more important than the formal lectures and recitations of a university are the intellectual influences which it affords, — the attractions of its libraries and laboratories; the spirit which animates the professors; the conditions upon which degrees, fellowships, and other academic honors are bestowed; the connection existing between the studies of the place and the studies that are in progress in other seats of learning; and the prospects which are open to young men of character and scholarship at the end of their courses. The university which imparts to a large number of students good impulses, disciplines them with thorough training, encourages them with judicious counsel, and upholds before them lofty ideals, becomes an agency of great power in the advancement of the general welfare. It annually sends to every part of the land, into all the professions, into professorships, masterships, and other leaderships, those who are likely to be centres of light and influence in their various states.

The opening of this university occurred in 1876, at a time when many careful writers were engaged in the study of the progress of the United States during the first hundred years of national life. Important articles then published, on the state of the arts and sciences in America, and on the condition of American education, were carefully considered by those who were engaged in planning the new institutions in Baltimore. Among such papers there was one entitled 'Abstract Science in America,' by Professor Newcomb, which indicated "the points of view from which our claims to be an intellectual nation look very slender indeed." The writer acknowledged the excellent quality of the work which was done by the leaders of American science, while he lamented the want of encouragement to engage in such labors. He declared that "we are deficient in the number of men actively devoted to scientific research of the higher types, in public recognition of the labors of those who are so engaged, in the machinery for making the public acquainted with their labors and their wants, and in the preliminary means for publishing their researches." He continued to say, —

"Each of these deficiencies is to a certain extent both cause and an effect of the others. The want of public recognition and appreciation is due partly to a want of system and organization, partly to the paucity of scientific publications. The paucity of research is largely due to the want of adequate reward in public estimation and recognition; while the paucity of scientific publications is due to the want of an adequate number of supporters. The supply of any one of these deficiencies would, to a certain extent, remedy all the others; and, until one or more are so remedied, it is hopeless to expect any great improvement. In other intellectual nations, science has a fostering mother, — in Germany the universities, in France the government, in England the scientific societies; and, if science could find one here, it would speedily flourish. The only one it can look to here is the educated public; and, if that public would find some way of expressing in a public and official manner its generous appreciation of the labors of American investigators, we should have the best entering wedge for supplying all the wants of our science.

"The other way in which help could be most effectively given at small expense is by the support of two or three first-class journals of exact science. We say exact science, because this is the department which is worst supplied in this respect. Taking mathematics at one extreme, and medicine at the other, we can pretty accurately gauge the exactness of each science by the difficulty its cultivators find in supporting journals devoted to it. It may seem like reducing our thesis to the ridiculous to say that our wants in this

respect could be well supplied at a cost of five or six thousand dollars per annum, and that the future prospects of the mathematical sciences in this land depend very largely on their cultivators being able to command this annual sum for the purpose indicated."

In two of the particulars just mentioned — the encouragement of advanced studies and the publication of results — this foundation has aimed to do its part. By precept and example, hundreds of young men have been trained in the methods of exact science and the habits of accurate investigators. Not a few of these students have been called into the scientific service of the government; many are engaged in laboratories, scientific and technical; more are employed as teachers in training up other young men. The university can point to no result of its efforts which is so gratifying, and which so thoroughly repays the outlays of this foundation, as the corps of graduates who have gone out to every part of the country, prepared to contribute to the progress of knowledge, and who are now rendering good service to science, literature, and education. By encouraging the publication of journals and monographs, this foundation has endeavored to supply another of the deficiencies referred to above. Five periodicals, devoted to mathematics, chemistry, biology, philology, and history, have been aided by the university chest; and three others, devoted to archæology, psychology, and modern languages, have been initiated on the personal responsibility of certain members of the academic staff.

President Gilman then considered the higher aspects of the work of the university, especially during the last session.

The subject of mathematics has received a large amount of attention in the years gone by, as every one knows who remembers the seven years' leadership of Professor Sylvester, the special courses given by Professor Cayley and Sir William Thomson, and the continued instruction of the present staff of mathematicians. Every one that has an appreciation of the nature of mathematical thought, or of its relation to the advancement of science, must rejoice that this has been so. Dr. Whewell once claimed that mathematics and civilization go forward hand in hand; and quite recently Lord Rayleigh, in reply to some contrary assertions, has said that although some mathematicians are unpractical, yet it is to mathematics one must go to find the results of known causes under new circumstances.

It has always been a surprise to President Gilman that so few Americans are interested in the new and advancing developments of this science, and that so large a number of those who are giving their lives to mathematical professorships prefer to walk in well-trodden paths without attempting to follow the higher flights of the leaders. The number of mathematical students at Johns Hopkins has never been large; but the teachers continue to offer varied advanced courses attractive to a superior class of students, and those who graduate in this subject are not often obliged to wait for a vocation. In addition to the usual number of mathematical lectures, stated in the appendix, there has been a noteworthy advance during the past year in the facilities for the study of astronomy, theoretical and practical, and there has been a considerable increase in the number of students.

An observatory for instruction is now provided. Besides the telescope mentioned in the last report, the university has purchased a meridian circle (made by Messrs. Fauth & Co. of Washington), with collimators, mercury basin, and other appliances. To receive this instrument, a special structure has been built adjacent to the physical laboratory. A class in practical and theoretical astronomy has been organized under the guidance of Prof. Simon Newcomb, for many years connected with the Naval Observatory in Washington, and now superintendent of the United States 'Nautical Almanac.' During the coming year he will be assisted by Mr. Charles A. Borst, lately one of the astronomical observers of Hamilton College, who has received the appointment of a fellow.

From these statements it is apparent that the university is now provided with the most important of the astronomical apparatus suggested many years ago by Professor Newcomb, in one of his public lectures, as desirable for the practical instruction of astronomers. It has also the qualified teachers, and a company of students has begun the prescribed course. The further development of this department of study will be watched with great interest. Its distinctive character is its adaptation to the needs of young men, already proficient in mathematics, who need to be trained in the methods of astronomical inquiry, and who want easy and constant access to suitable instruments, as they have in the laboratories of chemistry and physics.

One leading idea of the work is to associate with the technical study of the subject a greater breadth of culture than can readily be gained by the student whose attention is wholly occupied by practical work in the observatory or the field. It is therefore intended that all students taking the doctor's degree in astronomy as their principal subject, shall have an understanding of the historic development of the science since its beginning, of the additions made to it by its leading cultivators, of the mathematical theories of the celestial motions, and of the practical use of the most important astronomical instruments.

The *American Journal of Mathematics*, of which Professor Newcomb is editor, and Associate Professor Craig the assistant and managing editor, has completed its tenth volume, and an index of the contents of the entire series has been prepared for publication. Eight of the contributors to the tenth volume are Americans; four reside in England; four in France; and one each in Canada, Italy, and Germany.

The mathematical staff remains as it has been for several years past, Drs. Story, Craig, and Franklin being associated with Professor Newcomb.

The new physical laboratory justifies the expectations which led to its construction, not merely in view of the increased facilities it affords for instruction, but also for the greater efficiency with which investigations are carried on.

During the past year, Professor Rowland has continued to devote much attention to the study of the solar spectrum, and the preparation of a new edition of his photographic map. The new ruling-engine, which was completed a year ago, has been placed in the vault prepared for it, where the temperature is equable; and, after months of laborious adjustments and connections, the machine has been so perfected that it rules gratings of the largest size, surpassing in definition any that have been obtained before. Several concave gratings six inches in diameter, and with a radius of more than twenty-one feet, have been ruled with from ten to twenty thousand lines to the inch, and they have been mounted in a large room especially adapted to their service. It is chiefly due to the excellence of these gratings that the new photographic maps are so superior to the old. Something is due also to the constant attention Professor Rowland has given to photographic methods, and to his skill in making dry plates, simple and orthochromatic. The result of this long and laborious preparation has been the production of a map, soon to be published, of the normal solar spectrum, extending from the extreme ultra-violet (down to and including B) to wave-length 6950.

The director of the laboratory has been greatly favored in the prosecution of his work by the services of the associate professor in physics, Dr. Kimball, who has given for several years past the general course of instruction, and has personally guided the laboratory-work of the students.

The special course of instruction in electricity and magnetism has been in charge of Dr. Duncan, and it has been found to meet the wants of students who have an aptitude for both mathematical and experimental work. Four such persons, after a special course of study extending through two years, and after satisfactory final examinations, received special certificates at Commencement.

With the unusual facilities now enjoyed by Professor Rowland, it is natural that his principal work during the past year has related to the nature of light. Under his guidance, progress has been made in determining the absolute wave-length of light, and the relative wave-lengths of lines in the ultra-violet portion of the solar spectrum. The spectrum of hydrogen has been studied under various conditions of excitement and pressure; and the spectra of zinc, cadmium, and magnesium have been studied photographically and the wave-lengths measured. So, also, various bands of the carbon spectrum from the electric arc have been investigated, an algebraic expression of the relation between their wave-lengths has been obtained, and the coincidence of the bright lines of the carbon spectrum with the dark lines of the solar spectrum has been verified. Additional measurements have been made on the displace-

ment of lines in the solar spectrum due to the rotation of the sun.

Important work has also been going forward with respect to electricity and magnetism. A determination has been made of the unit of electrical resistance by the method of Lorenz, and a study has been made of the electrical resistance of pure mercury with reference to the value of the mercury unit. The curves of electromotive force and current in an alternating dynamo, under varying conditions, have been studied, and also the chemical changes in storage-battery cells, and the behavior of different insulating substances under various conditions.

Arrangements have been matured for the testing of electrical instruments and standards for other laboratories, scientific and industrial. This work, under the supervision of the chief instructors, is intrusted to Dr. Liebig. Correspondence between Dr. Duncan, associate in electricity, on one part, and the leading electric manufacturers and the professors of physics in different parts of the country, on the other, has indicated the need of such a bureau as is now established. Its actual utility will soon be demonstrated.

In this connection President Gilman writes: "I am unwilling to pass on from this subject without endeavoring to arrest the attention of the trustees, and through them the attention of other persons who are observing the development of this university, to the fundamental character of the researches which are here carried on, and to their ultimate relation to the welfare of human society. Costly laboratories, expensive apparatus, numerous assistants, the means of publication, unquestionably call for a great deal of money; and those who are concerned with economical problems have a right to ask what results are to be seen after all this outlay. The answer can readily be given with respect to all departments of science; but just now it is particularly easy to justify the expenses of a physical laboratory, because of the remarkable progress which is making throughout the world in the study of physical phenomena, and the discovery of principles hitherto vaguely perceived or entirely hidden.

"Those who are watching the progress of science are well aware that the year 1888 is memorable for the new evidence which has been brought to the support of Maxwell's electro-magnetic theory of light in the experimental discovery of long waves of electro-magnetic induction moving through the ether with the velocity of light. The papers of Hertz, presented by Helmholtz to the Academy of Sciences in Berlin, and the discussions to which they have given rise in the recent meeting of the British Association and in the scientific journals, are proofs of this remark.

"This is not the place for more than an allusion to such investigations; but some reference to them seemed called for, in order to show that there is constantly even now an advance. The conception of a Faraday, developed by the powerful analysis of a Maxwell, is submitted to the laborious tests of the laboratory; one after another agreements and coincidences are found; facts insignificant in themselves become weighty with importance when seen in their relation to others; and finally some far-reaching result, like that of Hertz, compels belief, and gives to the world a new truth as a part of its inestimable treasure of knowledge, enriching the intellectual life of all who come after.

"Another illustration may be found in the address of Professor Langley at the Cleveland meeting of the American Association. Under the title of 'The History of a Doctrine' (radiant energy), he has unfolded, in terms which are easily followed by 'the non-mathematical reader' (and even by the 'non-scientific'), the steps by which science has reached its present stage, and is still advancing in the discovery and interpretation of a fundamental truth.

"In this progress the work of a laboratory is most important. The photographic maps of the sun spectrum and of the spectra of metals, and the measurement of the wave-lengths of light, among the labors that have engaged our own investigators, relate directly to fundamental questions in physics and chemistry.

"The diffraction gratings devised by Professor Rowland are of prime importance in the prosecution of these studies of light. In all the principal laboratories of the world they are in demand, and consequently their manufacture is continued, although it requires a large amount of personal supervision from the director. The measurement of the mechanical equivalent of heat is a fundamental factor in establishing the doctrine of the conservation of energy, and lies at the basis of the modern theory of the steam-engine. So, also, the solution of problems in electricity and magnetism, besides giving glimpses into a realm of nature still enshrouded with mystery, has a direct bearing on the welfare of the race, by advancing that knowledge which enables mankind to make the forces of nature obedient slaves.

"My object in thus dwelling upon the returns which have come, and are likely to come, from large expenditures of intellectual force and of financial resources, is to invite attention to an opportunity for the endowment of 'the ——— Institute of Physical Science' in the Johns Hopkins University. The admirable laboratory that has been built and well equipped, from the mechanic's shops in the basement to the telescope in the tower, is in itself an enormous and complex piece of apparatus for the prosecution of researches. Its staff of teachers and investigators are constantly looking to the advancement of knowledge, and maintaining a helpful attitude toward the practical applications of science. A serviceable way to keep up and extend the efficiency of this laboratory would be to provide it with a fund of its own, to be perpetually and exclusively devoted to the advancement and diffusion of knowledge in this special domain. More than a hundred years ago an American citizen, well known as Count Rumford, established in this country and in England large funds for the promotion of investigations in light and heat. The good accomplished by his gifts is incalculable, and the lustre of his name increases as the years roll on. Who will follow his example?

"If there are any friends of the university who are anxious to know what are the practical results of abstract science or of recondite and to them incomprehensible researches respecting energy, let them read these words of Professor Langley, 'The doctrine of radiant energy is reaching out over nature in every direction, and proving itself by the fact that through its aid nature obeys us more and more, — proving itself by such material evidence as is found in the practical applications of the doctrine, in the triumphs of modern photography, in the electric lights in our streets, and in a thousand ways which I will not pause to enumerate;' or these words of Professor Fitzgerald,[1] 'Let us for a moment contemplate what is betokened by this theory that in electro-magnetic engines we are using as our mechanism the ether, the medium that fills all known space. It was a great step in human progress when man learnt to make material machines, when he used the elasticity of his bow and the rigidity of his arrow to provide food and defeat his enemies. It was a great advance when he learnt to use the chemical action of fire; when he learnt to use water to float his boats, and air to drive them; when he used artificial selection to provide himself with food and domestic animals. For two hundred years he has made heat his slave to drive his machinery. Fire, water, earth, and air have long been his slaves; but it is only within the last few years that man has won the battle lost by the giants of old, has snatched the thunderbolt from Jove himself, and enslaved the all-pervading ether.'"

The work of the chemical laboratory, having been well organized for a longer period than that in physics, calls for less comment. Professor Remsen continues to be the director, and Dr. Morse the sub-director, and Dr. Renouf and several younger men are engaged as assistants and teachers. If increasing numbers are an indication of success, there is every reason to be gratified, for during the past year every available place in the laboratory has been occupied. But numerical success is not the best test of any branch of university-work. The readiness with which the young men who have here been taught are called to good positions, sometimes as teachers and sometimes as chemists in technical occupations, is an indorsement more significant than any numerical statement. All the arrangements of the laboratory are adapted to those who desire to devote a long period of time to this study, and those who wish for short and special courses are not encouraged to come here. Three or four years of study is usually required of those who have had already such an undergraduate course as is here given, before they can proceed to the degree of Doctor of Philosophy. The director of the laboratory continues to edit the *American Chemical Journal*, which has now nearly reached the conclusion of its tenth volume,

[1] Address at Bath, Eng., September, 1888.

and has taken its place among the chemical journals of the world as the chief repository of what is accomplished in this country for the advancement of the science.

The geological work in progress at the university is in part petrographical, in part structural, and in part paleontological, in its nature.

The study of interesting chemical and microscopical problems relating to the alterations which certain minerals undergo in the earth's crust, commenced by Dr. Williams five years ago (in the black gabbros occurring west of Baltimore), and published as Bulletin No. 28 of the Geological Survey, has since that time been pursued in widely separated regions. One series of articles on analogous rocks occurring near Peekskill, N.Y., has already appeared, while an extended memoir on similar phenomena observed in the Lake Superior region is now passing through the press in Washington.

At the present time all the varied and complicated crystalline rocks of Maryland, occupying an area of two thousand square miles, are being mapped upon a scale of two inches to the mile. This work has been undertaken in connection with the United States Geological Survey, and is under the direction of Dr. Williams. Chemical and microscopical studies of the rocks are carried on in connection with the field-work.

Dr. W. B. Clark, who has been connected with the university during the past year, is engaged in original research in paleontology.

In response to a request from the university, Major J. W. Powell, director of the United States Geological Survey, has caused to be made a survey of Baltimore and its environs, in general conformity with the scheme which is in progress for making a topographical map of the entire country. The survey of the Baltimore region was intrusted to Mr. Sumner H. Bodfish, topographer of the survey, assisted by Mr. J. H. Jennings, assistant topographer of the survey, and Mr. E. G. Kennedy, and the work is now nearly ready for publication.

The past year has seen improved organization in the department of psychophysics, and likewise the unexpected interruption of its activity. Suitable rooms for experimental work were provided in the physical laboratory, instruments and apparatus were bought, and the services of an associate well trained in the methods of physiological inquiry were enlisted. Arrangements were perfected for clinical observations and for the examination of pathological conditions of the nervous system. Nor were the wider aspects of psychology neglected; the history of philosophy and the principles of pedagogics were taught. The publication of the *American Journal of Psychology* was begun, with the financial encouragement of a liberal friend. An increasing number of well-qualified students were attracted by the learning, the enthusiasm, and the sympathy of Professor Hall. Near the close of the academic year, he received an invitation to become the head of Clark University. No successor has as yet been nominated.

Since the foundation of this university, the biological sciences have received special encouragement, partly because of the rapid advances that they have been making, and partly because of their relation to the progress of modern medicine. Prolonged courses of training are arranged for those who propose to devote their lives to investigation or to teaching in these branches, as well as for those who intend at a later period to study for the profession of physicians and surgeons. As in physics and chemistry, abundant facilities for laboratory-work are called for; instruments, materials, and assistants have been and must be liberally provided.

The science of biology includes the study of the forms and functions of living beings in their normal conditions, or, in other words, physiology and morphology; and in both these departments animal and vegetable life must be studied. Professor Martin, director of the biological laboratory, gives his chief attention to physiology; and Dr. Brooks, director of the marine laboratory, to morphology. Dr. Howell, now associate professor, is the chief assistant in biology; and during the past year aid has also been received from Dr. Andrews, Dr. Barton (in botany), and others.

In considering the work of the session, mention will be first made of the courses that are planned for beginners. The director believes that such students have never been more efficiently taught than during the past year, and the result is indicated by an increase in the number enrolled for the session of 1888–89. When it becomes understood that a medical education should always be based upon an intimate acquaintance with the laws of life and the activities of normal and healthy beings, young men will not fail to avail themselves of such preliminary training as is here afforded; but, as most of the medical schools of this country prescribe no conditions of scholarship as essential for beginners, it is no wonder that the number of future physicians who are willing to take preparatory instruction in biology is small. It is a great satisfaction, however, to observe that those who have this thorough foundation rise surely and quickly to professional excellence.

The results of many of the original researches in the department have already been published in abstract in the *University Circulars*, the *Zoologischer Anzeiger*, and elsewhere; some of the remainder have been published in full in the *Studies from the Biological Laboratory* and in other journals.

Three numbers of the fourth volume of *Biological Studies* were printed during the year; and a volume containing Dr. Bruce's observations on the embryology of insects and arachnids was issued with the co-operation of his friends in Princeton.

The unusual opportunities which have here been provided for students to become acquainted with the most recent methods of pathological investigation are but little known, partly because of their novelty, and partly because pathology has been usually regarded as a branch of a distinctly professional education. Looking forward to the time when a medical school will be organized, — in close relations to the Johns Hopkins Hospital, on the one hand, and to the philosophical faculty of the university, on the other, — the trustees in 1883 determined to supplement the physiological work already directed by Dr. Martin, with a new department of pathology, in which the most recent and approved methods of research should be introduced. Dr. William H. Welch of New York was appointed professor of this science, and, after a year's residence in Europe, he began the organization of a laboratory in a building (that had been constructed for autopsies) on the grounds of the Johns Hopkins Hospital. All the apparatus required for such investigations has been provided by the trustees. Cultures of a large number of pathogenic micro-organisms have been collected, and likewise a great deal of material illustrative of human and comparative pathology. The laboratory is open and teachers are present during the entire day.

Instruction is given in general pathology and in the special pathological histology of all the organs of the body, in experimental pathology, and in the method of making autopsies. Bacteriology receives a great deal of attention. Students are taught to study the forms, growth, and functions of bacteria and fungi, particularly those which are related to disease. They have also an opportunity to become acquainted with the methods of biological examinations of air, water, etc. There is hardly any branch of human knowledge which is growing so rapidly, and which gives promise of such good fruit, as that which includes the laws of life in health and disease. Education for the medical profession of this country must soon be re-organized in accordance with modern developments. In this re-organization laboratory methods are to play a most important part; and young men who have been trained in physics, chemistry, and general biology are coming up to the school of medicine ready for further scientific studies, especially in the laboratory of pathology. Here, among other subjects, they must be taught the relations of bacteria to disease, and the changes in structure and in function produced by disease in the various organs and tissues of the body. They must be able to understand the discoveries now in progress, to weigh their significance, to see their bearing upon diagnosis and the treatment of disease. Hence it is that at so large a cost this university has given such vigorous support to its school of pathology, and has aimed to equip the laboratory so completely with the requisite apparatus and with the material needed for study.

DR. H. CARRINGTON BOLTON is about to undertake a journey to Egypt. From January 1 to May 1, 1889, letters may be addressed to him, care of Brown, Shipley, & Co., London, England.

STANLEY AND EMIN PACHA.

WHILE the Arabs in Suakin were reported to have captured Emin Pacha and Stanley, news reached Leopoldville that Stanley had returned to the Kongo, and the indications are that this report is trustworthy. The first telegram was from Zanzibar, dated Dec. 21: —

"Letters dated Stanley Falls, Aug. 28, have been delivered here by Tippo-Tip's men. They state that a letter was received at Stanley Falls from Henry M. Stanley on Aug. 28. Stanley was then at Banyala, on the Aruvimi, where he had arrived on Aug. 17. He had left Emin Pacha eighty-two days before, in perfect health, and provided with plenty of food. Stanley had returned to Banyala for the loads of stores in charge of his rear guard, and intended to leave ten days later to rejoin Emin. He reported all the whites in the expedition as healthy, and said the expedition wanted nothing. In the Stanley Falls advices it is stated that Stanley wrote that Emin was in possession of vast stores of ivory and many oxen, and that he had an abundance of food. Stanley intended to leave Banyala at the end of August."

This was followed by another despatch, stating that these messengers came by way of Udjidji and Unyanyembe. They were said to confirm the other accounts, that Stanley had left Emin with Casati, and that both were perfectly well.

On Dec. 22 this news was amplified, and the following detailed telegram sent from Zanzibar: —

"One of the special messengers sent into the interior in October, in the hope of obtaining news of Emin and Stanley from caravans, has sent a despatch announcing that he met Arab traders from Wadelai, who positively affirmed that Stanley met Emin there about Jan. 20. Stanley, the traders said, had 330 men and plenty of stores. He had endured great privations, but he and all his party were well, although extremely exhausted. The delay in reaching Wadelai was due to difficulties encountered on the route, the expedition having to make a long détour toward the north-east in order to avoid swamps and hostile tribes.

"Emin was then in a fairly good position, although some of his Egyptian officers were grumbling, and many of his soldiers had deserted. The Kings of Uganda and Unyoro were hostile to Emin, who was obliged in November to repel predatory incursions from the east. His general health was good, but he had been suffering from an affection of the eyes for two months.

"A fortnight after Stanley's arrival, Emin received, *via* Lado, a message from the Mahdi pompously intimating his intention to subdue the whole country as far as the great lakes, and promising good treatment if Emin submitted. Emin replied that before evacuating he must wait for the Mahdi to prove the legitimacy of his claim to the province.

"Stanley, in the mean time, applied himself to restoring order among the troops, and distributing stores and munitions. Emin told Stanley that he did not desire to leave Wadelai. The entire route to the east coast was most dangerous on account of the incessant agitation among the tribes and the hostility of Mwanga. Toward the middle of April, hearing that a force of Mahdists was coming, Emin ordered his advanced posts between Dufile and Lado to retire to Wadelai, and Stanley sent messengers to the Kings of Uganda and Unyoro.

"About the end of April, when the traders left Wadelai, Stanley was anxious, owing to the absence of news from the rear guard on the Aruvimi, and was arranging to send a strong detachment in search of them along the route which he himself had followed. Stanley also again urged Emin to leave Wadelai with him and regain the coast. Stanley sent out several couriers with news for Europe. One was the courier who was sent by the foreign consuls at Zanzibar to apprise Emin of the departure of the relief expedition. This courier had remained at Wadelai, and was sent back to the east coast after the arrival of Stanley. Another courier was sent in the direction of the Aruvimi."

By a remarkable coincidence a despatch giving information of a similar character was sent from St. Thomas on Dec. 21, 2 P.M. It was stated that Stanley, with Emin Pacha, had arrived on the Aruvimi. This news was confirmed on the following day in a telegram to King Leopold of Belgium.

It would be interesting to learn the exact time when the detailed Zanzibar telegram was despatched. Former events show that reports received from West Africa were telegraphed to Zanzibar, and returned wonderfully amplified. It is at least worth remarking, that on Dec. 23 the London *Times* received a despatch from Zanzibar stating that "no details have been received here of the reported meeting of Stanley and Emin." The Brussels telegrams, on the other hand, have generally proved trustworthy regarding the main facts.

There can be no doubt that Stanley had reached Emin about the beginning of the current year, and that he has retraced his steps to the Kongo. The news does not disprove the alleged capture of Emin Pacha. We may hope to receive further and more detailed news in a fortnight or three weeks.

SCIENTIFIC NEWS IN WASHINGTON.

Ojibwa Folk-Lore.

DR. W. J. HOFFMAN of the Bureau of Ethnology read a short paper at a recent meeting of the Anthropological Society of Washington, entitled 'Notes on Ojibwa Folk-Lore,' in which a brief review was given of his researches among that tribe of Indians during the years 1887 and 1888. He has finally succeeded in obtaining the ritual, mnemonic songs, initiation and pictographic charts embracing the cosmogony, and institution of the Midéwiwin, or Grand Medicine Society, and of the Dji bai Midéwigân, or Ghost Lodge.

The former consists of four distinct degrees, each of which may be entered by one, if properly prepared by the necessary preliminary fasts and visions, progress and acquirement of information in chants and prayers, and proficiency in the skill expected of a Midé, or Grand Medicine Man.

In addition to this, life-size sketches were exhibited to show the facial ornamentation adopted, and recognized as characteristic of each degree. The 'Ghost Society' is an organization closely connected with the Grand Medicine Society, and is considered to be the "lodge in which the departed Midé meet, to hold sessions, and initiations of newly arrived spirits of Midè who occupied honorable positions among the Indians of this world." When a boy who had been dedicated to the Grand Medicine Society dies, his father or mother may become members of the first degree of the Grand Medicine Society through the representatives of the Ghost Society, this partaking of the character of a proxy.

All the information about these two societies is now in preparation for publication by the Bureau of Ethnology.

Teton Folk-Lore.

The following statements were made by Rev. J. Owen Dorsey, in a paper entitled 'Teton Folk-Lore,' read before the Anthropological Society. The material used in the preparation of this paper was translated by Mr. Dorsey from a collection of Teton texts, written by George Bushotter, a Dakota Indian.

The Tetons believe that the buffalo used to dwell in subterranean lodges. When one sees a buffalo in a vision, the animal becomes his guardian, rendering him almost invulnerable, putting a real buffalo inside of him, and conferring on him the right to take part in the buffalo dance. In the olden times there was also another species of buffalo, about which marvellous tales are told.

On one occasion some Indians were attacked by one of these mysterious animals, and one of the party was killed. But the monster walked four times around the corpse, and said, "Arise!" Immediately the dead man revived. The monster said, "Hereafter you shall be mysterious. The sun, moon, four winds, day, and night shall serve you." From that time the man could assume any shape.

Gophers shoot at persons with the tip end of a species of grass, wounding them in the neck, and causing scrofulous sores. Warts betray a thief. If the skin of the hard palate peels off, the person is given to lying. Whoever makes a practice of eating the large intestines of cattle (the *ta-shi-ya-ka*) is sure to "be hit by the *shi-ya-ka*," i.e., he will have a boil. *Shi-ya-ka* is the name of the dabchick or grebe. The boil will be on some covered part of the body. The Tetons dare not go out on a windy night, lest the cause of

boils be blown to them. If a man eats the liver of a female dog, or a woman eats that of a male dog, the face will break out in sores. He who is given to eating the calves of the legs of any species of animals will have a cramp in the muscles of his own legs. Tetons are forbidden to wear women's moccasons, lest when they meet their foes they cannot run swiftly. Children are not allowed to put inverted bowls on their heads, because such a practice will make them stop growing.

Hunting-Lore. — He who steps in or on a bowl or dish will fail to wound any game: so dishes are turned upside down when not in use. When one wishes to extract the marrow, he must not split the bone in two. A violation of this custom will cause lameness or frequent pains in the legs. Whoever breaks marrow-bones awkwardly cannot become a good marksman. The shoulder-blade of a buffalo calf, or that of a doe, is hung on the outside of a tent, just above the entrance, to insure success to the hunter a day or two later.

Interesting University Statistics.

Among the statistical tables that are to accompany the forthcoming annual report of the Bureau of Education, none are more interesting than those relating to the universities, colleges, and scientific schools of the United States. They are more valuable than ever this year, because they are based upon more complete returns from the institutions, and their value is greatly enhanced by the very intelligent discussion of the tables by Miss Annie Tolman Smith of the bureau, who prepared them.

One suggestive table gives the statistics of twelve of the leading institutions of the country. They are Yale, Columbian University (Washington), Johns Hopkins (Baltimore), Boston University, Harvard, Dartmouth College, College of New Jersey, Cornell University, Columbia College (New York), University of the City of New York, University of Pennsylvania, and Vanderbilt University (Nashville). Of this table, it is remarked that the foundations of the institutions named "illustrate every source from which the material equipments of the highest order of institutions are likely to arise, excepting State or national bounty. All of them have progressed far enough to be judged by their actual work, and nearly all of them have achieved more than national distinction.

"The undergraduate work of five of these institutions is carried on in colleges of arts and schools of science having their distinct faculties and students; in three, schools of science have distinct recognition, although the faculties and students are not reported separately from those of the college of arts; in the remaining four, the undergraduates are classified by the subjects or courses of study pursued.

"Graduate departments, not professional, are reported from ten of the institutions. Seven of the ten report also professional schools, as do the two that do not report a graduate department. The graduate students include 7 per cent, and the professional students 50 per cent, of the students of their respective institutions.

"Ten of the twelve foundations in question report productive funds amounting in the aggregate to $24,567,745, which is 34 per cent of the total productive funds reported for all colleges of liberal arts, schools of science, and professional schools. The total receipts for the year as reported from ten of the institutions were $2,474,463, which sum was made up as follows: income from productive funds, 52 per cent; receipts from tuition fees, 32 per cent; State appropriations, 1 per cent; other sources, 15 per cent."

Another table gives the statistics of twenty-four State universities. "Fourteen of the universities report graduate students, and seventeen report professional students, the number of the former being 2 per cent, and of the latter 35 per cent, of the students of their respective institutions.

"With a single exception, all the State universities report their productive funds, the aggregate amount being $6,881,045. The total income reported for twenty-three of the universities is $1,302,042. This amount was made up as follows: income from productive funds, 32 per cent; receipts from tuition fees, 11 per cent; from State appropriations, 49 per cent; from other sources, 8 per cent. Tuition fees, it will be seen, form but a small proportion of the aggregate income; the details show, further, that in three cases only do they represent a comparatively large part of the individual incomes.

"The attendance upon post-graduate courses in the State universities is small as compared with the same in the twelve universities referred to above. The number of graduate students in the latter is 55 per cent of the entire number of such students reported from all colleges and universities.

"As regards professional schools, theology has no representation in the State universities, and but four schools, with 272 students, in the universities first mentioned.

"The law schools in the table of State universities number 14, with 973 students; and in the twelve universities not supported at public charge, 8, with 1,262 students. The number of medical schools in the State universities is 11, with 969 students; and in the twelve first mentioned, 9, with 2,412 students. The remaining professional students are distributed in dental, pharmaceutical, and veterinary schools.

"The theological students of the twelve universities represent 4 per cent of all such students reported; the attendance upon law schools in both tables, 70 per cent of all law students reported; and the attendance upon the medical schools, 28 per cent of the medical students reported for the country at large."

In this connection, the following facts derived from another source may be interesting to the reader: In 1882–83 the total cost of the Prussian universities was, in round numbers, $1,900,000. Of this sum, 9.3 per cent was their own earnings from tuition fees, etc.: the rest was the contribution of the State, 72 per cent being ordinary and the remainder extraordinary contributions, — for buildings, etc. In the same year the expenditure for gymnasien, including pro-gymnasien, was $3,813,355. The combined expenditure for universities and gymnasien was, in round numbers, $5,700,000.

Attendance upon Colleges and Scientific Schools.

A table is given showing the attendance upon the colleges and scientific schools of the country during the years 1875–76 and 1885–86, and the ratio which such attendance bore to the population at those dates. During the ten years there was a decrease of nine in the number of colleges, and an increase of ten in the number of scientific schools. The attendance upon the colleges at the later date was 7,072 greater than at the earlier period. The percentages of increase were 27 and 28 respectively, while the estimated increase of population during the same ten years was 25.

A comparative view of the relation of students to population by divisions shows an increase in the number of students as compared with population for colleges alone, and for both colleges and scientific schools, in the North Atlantic and North Central divisions of the country, and a decrease in the three remaining sections. It is only fair to remark that in making the computations for the South the colored population is included, and this brings the ratios of students to population down to 1 to 2,489 and 1 to 2,350 respectively in the two divisions of the South. If the blacks are excluded from the computation, the ratios of students in colleges to population in that section become 1 to 1,325 and 1 to 1,548 respectively, and the number in colleges and scientific schools combined 1 to 1,051 and 1 to 1,429.

HEALTH MATTERS.

Baldness.

THE cause of baldness, although long and diligently searched for, yet remains undiscovered. The theories to account for the loss of hair have been many and various. Mr. Eaton, in the *Popular Science Monthly*, attributed it to the wearing of tightly fitting hair coverings, living within doors, and keeping the hair closely cropped. He thinks, also, that this condition is exaggerated by the influence of heredity, and says that there is no reason why bald heads should not yield to the laws of heredity as much as curly or red heads. Mr. Gouinlock, in the same magazine, attributes baldness to the high hat and the hard felt hat, both of which constrict the blood-vessels which nourish the hair-bulbs. Dr. T. Wesley Mills, professor of physiology at McGill University, thinks that both of these views indicate the direction in which the truth lies, but that neither gets at it wholly. The degree to which such peculiarities as baldness are inherited is one of the most disputed matters. Exposure

of the body to sun and air has much to do with hair-production, as Mr. Eaton claims, and as to the truth of which any one may satisfy himself by leaving the arms or other portions of the body uncovered at the seaside or in the country.

Taking up the case against the stiff hat, Mr. Gouinlock explains how readily the arteries can be compressed, especially when the hair is cropped close. He thinks the fact that below the line of pressure the hair remains, while it disappears above it, is quite clear upon his theory; and, to account for the presence of hair over the temporal region when absent on the crown, he insists that here the temporal muscle acts as a cushion, preventing pressure. But this writer seems to forget that there are superficial and middle temporal arterial branches as well as deep ones, and that it is just these superficial ones (liable to pressure) that have most to do with supplying blood to the hair-bulbs. He also takes no account of other methods, besides pressure, by which blood can be cut off from a certain region. The familiar phenomena of blushing and pallor show that the nervous system has a controlling influence over the size of small arteries; and the fact that the hair may become gray in a few hours, under violent emotion, carries with it the lesson that in some way the nutrition of the hair is regulated by this same nervous system.

Dr. Mills says, that, to understand the physiological bearings of this subject, the somewhat complex relations of the blood-vessels of the brain, the face, the bones and muscles of the head, and of the scalp, must be borne in mind. The arteries of the brain find an outlet for their blood, when it has passed through the capillaries and done its work, in those peculiar venous channels lying on the inner tables of the skull known as 'sinuses.' These communicate with the veins of the softer osseous tissue (diploë) lying between the main tables of the cranial bones, which again have connections with the veins on the outside of the head. Now, it is plain, from this series of connections, that pressure on the scalp must influence the whole vascular system of the head back to the arteries of the brain, unless in some way counteracted. Pressure generally affects veins, from their superficial position, much more than arteries. The bad effects of venous dilation are seen in the slow-healing ulcers on the limbs of those with dilated (varicose) veins. Throughout his paper Mr. Gouinlock has directed his attention almost wholly to arteries rather than to veins. He has nowhere mentioned, what is commonly enough seen by the physician, that anastomotic arterial connections are especially opened up under the exigencies of disease, as from the pressure of tumors, etc.

Would Nature refuse to combat the hard hat? Could she not adapt to it in a greater degree than Mr. Gouinlock's theory supposes? In looking at a plate portraying the course of the arteries of the head, it will be noticed that the terminal branches mount to the vertex of the skull, and anastomose with their fellows of the opposite side by *very small* offshoots. As it is the smaller branches of arteries that are the most susceptible to changes in calibre,—can, in fact, be most readily influenced by the nervous mechanism,—it is easy to understand why that part of the scalp, with its hair-bulbs, supplied by them, should, either from pressure or from lessening of calibre in response to nervous influence, be the area most to suffer: hence the explanation of the fact that baldness of the vertex is the most marked. The great increase in the prevalence of all forms of nervous disease, and the modifications wrought in old forms of disease by the greater prominence of the nervous type of human being, point to the fact that our civilization makes calls upon the organization which tell especially on the nervous system. The strain of life falls in general, it will be conceded, most upon men. Man is the bread-winner: his anxieties, struggles, and disappointments are both many and severe; and man is often prematurely bald for the same reason that he is prematurely old in other respects. Woman is less so, because brain stress less frequently falls to her lot. But in connection with this must be taken, to complete the explanation, the fact, that, as with some races and some males of our own race, the vitality and persistence of the hair of the head in woman is specially marked. That overwork of the brain may influence the cephalic circulation (and so the hair) unfavorably, is evident enough from the dark circles beneath the eyes, owing to venous congestion, on the morning after unduly severe mental exercise, not to mention the headache from a similar cause; and it is not surprising that the vertex of the head, with its relatively variable and feeble blood-supply, should suffer most,—in a word, that the overworked or overworried man should be bald,—unless, as in most women, there is unusual vitality of his hair-bulbs. Baldness is one more of the many warnings of our day,—one of Nature's protests against the irregular and excessive activity maintained in this restless age.

PLASTERING WINES.—The Society of Pharmacy of Bordeaux some time ago appointed a committee to examine into the subject of *plâtrage*. This is a process in which plaster-of-Paris is added to wine both to clarify and preserve it. The effect of wine thus treated upon its consumers has long been a matter of doubt, some authorities regarding it as harmless, while others believed that such wine was injurious to health. The conclusions of this committee are as follows: 1. In the present state of viticulture in the south of France and in Algeria, the plastering of wines in the mash is almost always necessary, in order to give the wines the marketable qualities sought after by consumers; 2. Facts are wanting to show that plastered wines are injurious to health; 3. The experience of numerous populations that drink only plastered wine, the experience of the many strangers who are continually travelling through the south of France and Algeria, drinking hardly any thing else than plastered wine, and methodical experiments by learned bodies, show that potassium sulphate in the proportion of sixty grains to the litre of wine produces no appreciable effect on the various functions of the economy; 4. The plastering of wines in the mash to the extent of producing this proportion of potassium sulphate may be authorized until facts rigorously deduced from extensive scientific experiments show the dangers or inconveniences of this amount as regards the public health. The Academy of Medicine, through a committee, has been investigating the same subject, and its conclusions are as follows: 1. The testimony and the facts analyzed in the present report demonstrate that excessive plastering exerts an injurious influence on the public health; 2. From the exclusive point of view of hygiene, the commission cannot approve of the principle of the plastering of wines; 3. Nevertheless in view of the producers' and dealers' necessities, and especially taking the consumers' interest into account, it thinks that it would be imprudent to exclude from the market during certain years, by too absolute a measure, wines which thus far nothing but moderate plastering has proved capable of preserving; 4. Considering that, if potassium sulphate is a natural constituent of pure wines, it never exists in them in a proportion above sixty centigrams to the litre, as analysis shows; that it has not been directly proved that potassium sulphate, even in the proportion of two grams to the litre of wine, has any noxious influence on health, but that it is necessary to fix the maximum of potassium sulphate which may, without appreciable danger, be produced in wine by plastering,—the commission is of the opinion that the presence of potassium sulphate in the wines of commerce, whatever may be its origin, ought not to be tolerated beyond the maximum limit of two grams to the litre. The commission urges that the regulation formerly in force should be carried out strictly.

ORGANIC POISONS.—At the fifth annual meeting of the New York State Medical Association, held at Albany in October, the subject of ptomaines, leucomaines, and extractives, was discussed by several of the members. In speaking of the composition of ptomaines, Prof. Elwyn Waller of New York said that the presence of nitrogen, sulphur, and phosphorus had been determined. They were volatile unstable bodies, some of which could be represented chemically as ammonia in which more or less hydrogen was replaced by the radical CH_3, forming dimethylamine, trimethyldiamine, etc. Their action in the case of the poisonous members of the series when taken into the living body resembled that of the pyridic bases. Some produced a rapid dilatation of the pupil and weakening of the nervous centres, others loss of muscular contractility, others loss of cutaneous sensibility, others a slow action of the heart, others convulsions, others somnolence and torpor, and others pallor with profuse flow of the secretions. He thought that the ptomaines of cholera and typhoid had been found beyond much doubt. All ptomaines, leucomaines, and extractives were converted albumens. Leucomaines were midway between ptomaines and extractives, without definite boundaries between them. They were

divided into groups named uric and creatinic, from resemblances to urea and creatinine respectively. Sixteen were known. All represented progressive changes in albumen. All but one contained oxygen. They had been found in expired air, saliva, blood, brain, urine, pus, and the digestive tract. The progressive changes being interfered with so that retention occurred at some intermediate stage, or by-forms arising as a result of the interference, diseases might at once be produced. The neutralization of these products, even where made by bacteria, must, he thought, be more important than the destruction of the micro-organisms. Dr. N. B. Sizer of Brooklyn stated that canned meats usually owed their poisonousness to the presence of ptomaines, and not to the action of the soldering fluid used. In one instance canned apricots had contained a poison due to some alteration by decay, and resembling tyrotoxicon in its effects. It had killed the child of a nursing mother in a few hours, the mother in forty-three hours, and, after an illness of six days, the father also.

BOOK-REVIEWS.

The Civilisation of Sweden in Heathen Times. By OSCAR MONTELIUS. Tr. by F. H. WOODS. London and New York, Macmillan. 8°. $4.

PROFESSOR MONTELIUS'S excellent summary of the researches on prehistoric man in Sweden is well known to students of archæology, and an English translation of this standard work is highly welcome. The numerous cuts which illustrate the descriptions are of high order, and give particular interest to the handsomely printed book. Mr. Woods had the advantage of the co-operation of the author in translating the work, and thus the translation has become an enlarged edition. All the new matter and new plates that had been added to the German translation of 1885 have been incorporated in the English translation, and the results of recent investigations up to 1888 have been embodied in it. The number of plates has thus been swelled to two hundred and five. The book is pleasantly written, and unrolls a picture of the stone age, the bronze age, and the iron age so far as we are able to reconstruct it from the finds. The description of the last age fills almost two-thirds of the book. Professor Montelius assumes the end of the stone age to be about B.C. 1500. He describes the implements which were in principal use, and the methods of working stone; of chipping flints; and of making perforations by means of a stick and sand and water. A series of excellent cuts shows a great variety of unpolished and polished stone implements, axes, spear-heads, arrow-heads, knives, flint saws, etc. As remains of the earlier stone age are scanty in Sweden, the author dwells more particularly on the latter part of this age, and describes some of the most beautiful implements that have been found. The reader will, however, be particularly interested in the description of the mode of life of the people of this period, in which the author sums up the results of long-continued investigations. He describes the methods of hunting and fishing of this ancient race, their domestic animals, their clothing, and the probable existence of the beginnings of agriculture.

About the year B.C. 1500 the first bronze implements were introduced, and about the same time the first gold ornaments appear. As the forms of burial in the later stone age and the early bronze age are very much alike, Professor Montelius assumes that no immigration took place, but that the new art was introduced by intercourse with neighboring peoples. The bronze age is divided into two sections, characterized by peculiar ornamentations and different modes of burial. We cannot undertake to summarize the author's views, nor his terse description of the culture of each period, illustrated by cuts representing typical specimens and some of the important rock-carvings which are so numerous in Sweden.

The iron age is not absolutely prehistoric, numerous foreign coins being found along with remains of this age. Thus four periods are distinguished, the first reaching to the beginning of the Christian era, the second to the beginning of the fifth century. At this time the later iron age begins, the first part of which extends to the eighth century, while the latter terminates with the introduction of Christianity. In this part of the book the invention of the runes, and their connection with the Roman alphabet, are treated at some length. The accounts of the subdivisions of the iron age are fuller than the preceding chapters, as the finds are far more numerous, and illustrative of aspects of life of which no traces have been preserved in the stone and bronze periods.

Although the book deals only with the progress of the early inhabitants of Sweden, it is not less interesting, as all archæology tends to show that there has been a remarkably similar process of development, not only among European peoples, but among all races of the world. Therefore the author's clear and succinct account of the progress of this people will give the student a clear notion of the successive stages of civilization through which man has passed.

Experimental Mechanics. By Sir ROBERT STAWELL BALL, LL.D. London and New York, Macmillan. 12°. $1.50.

THIS volume is a revised edition of a course of lectures on experimental mechanics delivered some years ago at the Royal College of Science at Dublin to a large evening class consisting chiefly of artisans. The better to adapt his methods to the needs of so practical an audience, the subject has been so treated, that, for its ready comprehension, no knowledge of mathematics is required beyond an acquaintance with the rudiments of algebra and with a few geometrical terms and principles. The elementary laws of mechanics are well and clearly illustrated by simple experiments, the material for many of them being drawn from commonplace sources. Without at any time passing the limits set by the circumstances under which the lectures were delivered, Professor Ball has succeeded in presenting his subject in a lucid and extremely interesting manner.

AMONG THE PUBLISHERS.

D. APPLETON & CO. announce for this week 'The Florida of To-Day,' by James Wood Davidson, intended for settlers and tourists, giving the geography, climate, history, routes of travel, the geology, productions, sports, etc., describing the population, education, employments, etc., and including full list of hotels, and railway and county maps printed in colors. This is an entirely new work on this popular winter resort. 'Appletons' Handbook of American Winter Resorts,' revised for 1888 to 1889, will also be ready, with illustrations, railway time-tables and fares, maps, etc., brought down to latest date. A most useful guide for invalids and tourists.

— Robert Clarke & Co. of Cincinnati have in press, and will shortly issue, an octavo of 250 pages with the following title: 'Know Thyself: A Study of Man,' by a well-known Cincinnati physician, Dr. J. D. Buck. The book contains an outline of general biology and physiology, upon which the higher problems are based, and from which the true science of psychology must proceed.

— J. B. Lippincott Co. have in press a 'Life of Henry M. Stanley,' by H. W. Little; a 'History of the celebration of the One Hundredth Anniversary of the Promulgation of the Constitution of the United States,' edited by Hampton L. Carson; and 'A Shocking Example, and Other Sketches,' by Frances Courtney Baylor.

— *The Cosmopolitan* magazine has been purchased by John Brisben Walker, who will be remembered as the founder of the *Inter-Ocean*. Mr. Walker is establishing new headquarters at 363 5th Avenue, New York.

— J. W. Bouton, New York, will publish early next year a work on 'Remarkable Bindings in the British Museum,' for which Mr. H. B. Wheatley has prepared the text, and which is to contain sixty photogravure plates. "This is evidently intended," says the *Nation*, "to do for the British collection what M. Bouchot's sumptuous work did for the French; and, in recognition of the fact that the French interest in the art of bookbinding is greater than the English, there will be a simultaneous edition published in French by MM. Gruel and Englemann. The edition is limited to two hundred copies in English and two hundred in French.

— *The Princeton College Bulletin* is the title of a new quarterly publication to be issued from Princeton College. It will be philosophical, scientific, and literary in character, with President Patton as general editor, assisted in the various departments by several others.